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BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING
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Ser. X.

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

Vol. III.

Part 2. SIWAKIK AND NARBADA BUNODONT SUINA.

By R. LYDEKKER, B.A., F.G.S., F.Z.S.,

WITH 7 PLATES (Nos. VI.-XII.) AND 1 WOODCUT.

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ADDITIONAL CORRIGENDA IN VOL. II.

, note 2, for *page 143* read *page 103*.

, line 11 from bottom, for 1839 read 1836: (the same misquotation occurs in the "Pal. Mem.," l. I., p. 130).

, after *Mellivorodon palaeindicus* add 'n. sp.'

. The relative lengths of the molars of *Ursus arctos* are not constant.

, line 10 from top, and 276, line 20 from top, for *upper pliocene* read *lower pliocene*.

, note 2, and 354, line 19 from top, add *ser. 4* (1855).

. The premolar dentition of *Felis* is $\begin{smallmatrix} 2 \\ 2 \end{smallmatrix}$.

line 11 from bottom, for *Laizier* and *Pariere*, read *Laizer* and *Parieu*.

names *Hypohimys palaeindicus* (p. 158), *Hyenarctos palaeindicus* (p. 232), and *Ælurogale sivalensis* *dele* 'n. sp.'; and after *Hemimeryx* (p. 167) and *Sivameryx* (p. 169) *dele* 'n. gen.' The of 'n. sp.' and 'n. gen.' arose from a misinterpretation of a resolution of the Bologna 1881.

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Published July, 1884.

NOTICE.

The succeeding fasciculus will contain descriptions of some undescribed Siwalik Ruminants, and of the Siwalik Rodents. It will also contain a classified synopsis, with references, of all the Siwalik and Nerbada Mammals.

The author begs to inform his numerous palæontological friends who are kind enough to send him copies of their memoirs, that he has left the Geological Survey of India, and that his address is *The Lodge, Harpenden, Hertfordshire, England.*

CORRIGENDUM.

Page 37, line 16 from bottom, *for 1839 read 1836*: the error is owing to a misquotation in the "Palæontological Memoirs," vol. I., p. 130.

be so, the milk-molars mentioned above, and figured in plate XXXII. of the first volume, cannot belong to that species. Those teeth do not, moreover, belong to *M. angustidens*; and, for the reason mentioned above, it is improbable that they belong to *M. pandionis*. This is confirmed by the valleys of mm. 4 (vol. I., pl. XXXII., fig. 3) having no cement, being straight and very open, and the ridges low and nearly vertical. The cranium in which those milk-molars, together with m. 1, are contained, shows, moreover, no signs of the presence of premolars,¹ which there is every reason to believe were developed in *M. pandionis*, as in *M. angustidens*. On this view it seems highly probable that the milk-molars referred in the first volume to *M. falconeri*, really belong to a fourth Siwalik species of trilophodont mastodon.²

The only other interpretation of the serial homology of the tooth represented in woodcut fig. 6, would be to consider it as pm. 4. In that case it could not belong to either *M. angustidens* or *M. pandionis*, of which the corresponding teeth are known (pl. V.): and if it belonged to *M. falconeri*, then the milk-molars referred to that species in the first volume would have been succeeded by premolars, which was apparently not the case. It is, moreover, improbable, even if they were so succeeded, that they should be replaced by a tooth furnished with an entirely different kind of enamel: and on this view it thus seems probable that the above-mentioned milk-molars belong to a new species.

From the resemblance of the tooth represented in woodcut fig. 6 to the lower teeth of the type of those represented in plate V., figs. 4 and 6, it is not impossible that some of those in which the first ridge is the most worn may be the homologous lower milk-molars of *M. falconeri*.

Number of teeth known.—As the serial position of one of the teeth of this species figured in the first volume has been changed; and as other teeth there referred to the same species have been shown to be either probably or certainly specifically distinct, it may be well to give a revised list of the known teeth; viz.:—

(?) Mm. 3—Woodcut fig. 6, p. 32.

M. 2—*Ibid*, pl. XXXII., fig. 1.

M. 1—Vol. I., pl. XXXIII., fig. 3.

M. 2—*Ibid*, pl. XXXIII., fig. 4.

It may be observed that some confusion has arisen on pp. 209-10 of vol. I. in comparing the teeth of the present species with those of *M. angustidens* figured in pl. XL. of the "F.A.S.," owing to the circumstance that the latter are figured and described as upper teeth, when it appears that they belong to the lower jaw. The molars, as now restricted, of the present species appear to be very similar to those of *M. angustidens*; the main distinction between the two species being the difference in the form of the mandible, the superior size of *M. falconeri*, and the larger and taller talons of its lower molars. The Indian teeth of *M. angustidens* show that no distinction can be drawn as to the relative height of the crowns of the molars of the two species.

¹ *Ibid*, p. 208.

² The talons of the tooth represented in vol. I., pl. XXXII., fig. 3, are smaller than those of the tooth now regarded as m. 1 of *M. falconeri* (*Ibid*, pl. XXXIII., fig. 3).

Distribution.—Unless the specimen represented in woodcut fig. 6 really came from the Deccan, the present species is confined to the Siwaliks of the western Punjab and the lower Siwaliks of Sind.

FAMILY: *DINOTHERIIDÆ*.

GENUS: *DINOTHERIUM*, Kaup.

Alleged identity of Indian and European forms.—In a recently published memoir¹ Dr. O. Weinsheimer has come to the conclusion not only that all the European remains of *Dinotherium* should be referred to *D. giganteum*, but that the Indian forms² described under the names of *D. indicum*, *D. pentapotamiae*, and *D. sindiense* should likewise be regarded as belonging to the same species. Dr. Weinsheimer has had the advantage of a far larger series of specimens of the European form than were accessible to the present writer,³ and has shown pretty conclusively that the variation in size of the European form is so great as to include within its limits the two forms referred to *D. indicum* and *D. pentapotamiae*. Measurements are also given showing that the peculiar dimensions of the jaws of *D. sindiense* are paralleled by European specimens, and indicating that the present writer's suggestion that this form was unprovided with mandibular incisors is not improbably incorrect.

In India the mandibles of the forms known as *D. sindiense* and *D. pentapotamiae* are so perfectly distinct from one another⁴ (no specimens exhibiting any signs of a transition from the one to the other) that even if (as is highly probable) they both sprang from the same European stock, they may be regarded at the least as very well-marked local races; and the same may be said in a less marked degree of *D. indicum* and *D. pentapotamiae*. The present writer has not seen any last lower molar of *D. giganteum* presenting such a relatively large talon as the tooth of *D. pentapotamiae*⁵ figured in vol. I., pl. IX., fig. 5.

Although in view of the occurrence of *M. angustidens* on the western side of India it is by no means improbable that some of the Indian dinotheres (which are in the main found on the western side of that country) should be identical with a European form, yet in view of the great number of species of other Proboscidian genera in which the molars afford ample distinctive characters, it seems difficult to believe that *Dinotherium*, in which alone the simple structure of the molars does not admit of such distinctive characters, should be represented only by a single species ranging over the greater part of the Old World. On these grounds the writer is disinclined to admit at present the specific identity of the whole of the Indian dinotheres, which present a very remarkable amount of variation in size and the form of the mandible, with *D. giganteum*.

¹ "Ueber *Dinotherium giganteum*, Kaup," in Dames and Kayser's 'Palæontologische Abhandlungen,' vol. I., pt. 3 (Berlin, 1883).

² *Supra*, vol. I., pp. 72-5, 183-97, 292, pls. IX., XXIX.-XXXI.; and vol. II., pp. 63-4.

³ Many works cited by Dr. Weinsheimer were inaccessible to the present writer.

⁴ The figures do not exhibit these distinctions at all clearly.

⁵ Described at first as m. 1.

INDIAN TERTIARY & POST-TERTIARY VERTEBRATA.

SIWALIK AND NARBADA BUNODONT SUINA.

By R. LYDEKKER, B.A., F.G.S., F.Z.S.

(WITH PLATES VI. to XII.)

INTRODUCTORY.

In the fifth part of the preceding volume of the present work the remains of a large number of animals whose nearest existing allies are to be found in the pigs and hippopotami were described, and referred to a group termed the Suina Selenodontia. It was then shown that this group connects the living, or bunodont, Suina with the modern Ruminants; and that such a complete transition is thus effected between the three groups that it is impossible to draw any real distinction between them; although their retention for the purposes of classification is convenient. It is the group of Suina Bunodontia which forms the subject of the present memoir.

The fossil Indian representatives of this group may be referred to the four following families; *viz.*, *Hippopotamidae*, *Suidæ*, *Entelodontidae*, and *Listriodontidae*; which will be treated of in this order. A large series of the remains of the two first families are figured in the "Fauna Antiqua Sivalensis"; although in most cases they have never been described. These figures, although generally of a smaller size than is altogether desirable, are so good in execution as to render their reproduction in the present volume unnecessary.

The comparatively simple structure of the molars of nearly all the members of the group indicates that these animals are more nearly related to the primitive ungulates than any other living artiodactyle group. The structure of their feet, and especially the form of the astragalus, indicates, however, that at all events the modern representatives of the group are very far removed from the primitive stock: and it is noteworthy that the hippopotamus, in which the dentition is more specialized than in the pig, has retained more of the primal foot-structure than the latter. The

cheek-teeth of the pigs are remarkable for the circumstance that the first true molar becomes worn to a smooth surface of dentine before the last molar comes into use. and this remarkable inequality in wear, together with the elongation of the latter tooth, which is very markedly developed in some forms, shows how easily a transition might have taken place from the teeth of a pig-like animal to those of a trilophodont mastodon: and from this, and other circumstances, the writer is strongly inclined to believe that the pigs and proboscideans were connected at no very distant (geological) date.

A noteworthy circumstance is the disappearance at the present day of all the selenodont Suina; this being accompanied by the disappearance of a Siwalik pig (*Hippohyus*), in which the dentition is of a more complex type than in any of its kindred. This disappearance may perhaps be explained by the probability that the more specialized selenodont Suina entered into competition with the still more specialized ruminants, to which they had probably given origin, but were unable to stand against the advantages gained by the higher organization of that group; while the less specialized group of Suina confined themselves more or less exclusively to swamps, and, therefore, did not enter into competition with the ruminants, and thus survived.

ORDER: UNGULATA. SUB-ORDER: ARTIODACTYLA.

SECTION: SUINA. SUB-SECTION: BUNODONTIA.

FAMILY I.: HIPPOPOTAMIDÆ.

GENUS: HIPPOPOTAMUS, Linn.

Syn. *Chæropsis*, Leidy; *Hexaprotodon* and *Tetraprotodon*, Falc.

Affinities.—The present genus, in which, as will be shown in the sequel, it appears desirable to include all the hippopotami, is apparently the only representative of the family, and is remarkably isolated, both in the present and past time. In respect of the form of the skull and mandible the genus comes nearest to *Merycopotamus*, and is thus intimately connected with the *Anthracotheridæ*¹: in the structure of its molar teeth it is, however, widely different, and in this respect seems to be nearest to the Siwalik genus *Hippohyus* (described in the sequel), whose molar dentition, as remarked above, is of a peculiarly specialized structure. The molars of the hippopotamus also present a very remarkable resemblance to those of some of the Sirenia; from which circumstance, together with certain resemblances in the structure of their brains, it has lately been suggested² that these animals are very closely allied. It is, however, just possible that this resemblance may be due to the somewhat similar mode of life of the hippopotamus and the Sirenia.

¹ It is in great part owing to this relationship that the writer divides the Artiodactyla into the Suina and the Ruminantia, instead of into the Bunodontia and the Selenodontia. In the latter arrangement the hippopotamus and *Merycopotamus* would be widely separated.

² Chapman, 'Proc Acad Philadel,' 1881, p. 126

Number of species.—The following list comprises the non-Indian species of the genus; and indicates the variation in the number of incisors:—

1. HIPPOPOTAMUS AMPHIBIUS, Linn. Up. pliocene to recent, Europe and Africa.

H. abyssinicus, Less.

H. major, Cuv.

H. annectans, Falc.

H. senegalensis, Desm.

H. capensis, Desm.

Tetraprotodon amphibius, Falc.

Tetraprotodon major, Falc.

I. $\frac{3}{1}$: the inner pair much larger than the outer: one instance is recorded of three incisors in one ramus of the mandible.¹

2. HIPPOPOTAMUS HIPONENSIS, Gaudry.² Pleistocene (?), Algeria.

Hexaprotodon hipponensis, Gaud.

I. $\frac{1}{1}$. A small species, distinguished by the smooth enamel of the lower incisors; which tend to expand at their extremities, and thus indicate affinity with the pigs.

3. HIPPOPOTAMUS LIBERIENSIS, Morton. Recent, W. Africa.

Charopsis liberiensis, Leidy.³

Tetraprotodon liberiensis, Falc.

I. $\frac{2}{2}$. Much smaller than *H. amphibius*.

4. HIPPOPOTAMUS MINUTUS, Cuv.

Tetraprotodon minutus, Falc.

I. $\frac{2}{2}$. Considered by Gervais⁴ to be closely allied to *H. liberiensis*.

5* HIPPOPOTAMUS PENTLANDI, H. von Meyer. Pleistocene, S. Europe.

Tetraprotodon pentlandi, Falc.

I. $\frac{3}{1}$. As large as *H. amphibius*, with which Prof. Gaudry⁵ thinks it may be identified.

H. medius, Cuv. = *Halitherium*.

Distribution.—The genus is confined to the Old World, where it formerly had a wide distribution: its earliest appearance in Europe is in the upper pliocene.

Species 1: HIPPOPOTAMUS SIVALENSIS, Falc. and Caut.

Syn. *Hexaprotodon sivalensis*, F. and C.

History.—This species was originally described by Falconer and Cautley⁶ in 1839 on the evidence of a very perfect specimen of the cranium from the Siwaliks; which, with numerous other specimens, was subsequently figured in the "F.A.S." At a later date the species was subdivided by M'Clelland,⁷ but apparently on insufficient grounds. The name *Hexaprotodon* was originally applied by Falconer and Cautley in a sub-generic sense, but was adopted as a generic term by Sir R. Owen.⁸

¹ Gaudry, 'Bul. Soc. Géol.,' ser. 3, vol. 4, p. 504. Falconer ('Pal. Mem.," vol. II., p. 406) records another so-called instance of hexaprotodontism. The specimen on which this statement rests is in the Museum of Trinity College, Dublin, where the present writer has examined it: the extra tooth is malformed and very small, and situated on the alveolus of the canine. It can be in no sense regarded as a reversion, but is merely a redundancy: the additional incisor of the hexaprotodont form should occur between the two incisors of the living hippopotamus.

² *Op. cit.*, p. 501, pl. XVII.

³ 'Journ. Acad. Philadelp.,' vol. II., 1853, p. 207.

⁴ "Zool. et Pal. Gen.," 1st ser., p. 250.

⁵ *Op. cit.*, p. 504.

⁶ 'Asiatic Researches,' vol. XIX, p. 39. "Pal. Mem.," vol. I., p. 130, pls. XI., XII.

⁷ Plate LIX, *et. seq.*

⁸ 'Journ. As. Soc. Beng.,' vol. VII., p. 1038: it is unnecessary to quote M'Clelland's names.

⁹ "Odontography," p. 566, pl. CXLIII.

Typical crania.—The type cranium is in the British Museum and is figured in

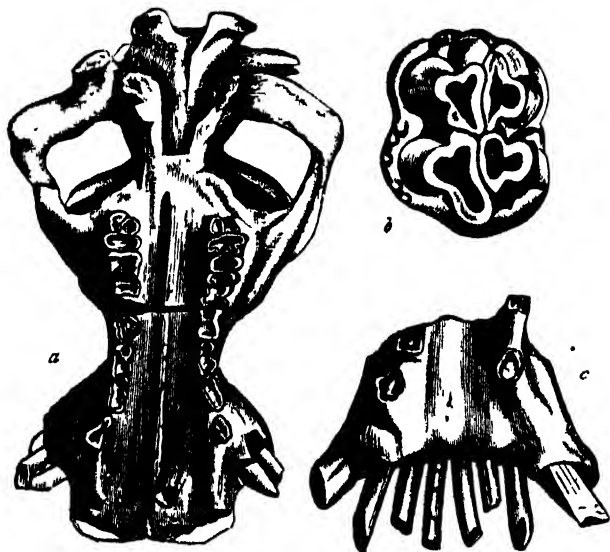


Fig 1. *Hippopotamus siwalensis*, F and C.: a, palatal view of type cranium, with the teeth much worn, $\frac{1}{2}$. b, third right upper true molar in an early stage of wear, $\frac{1}{2}$. c, upper view of anterior portion of mandibular symphysis, $\frac{1}{2}$. All the specimens are in the British Museum, and came from the Siwaliks

species, was separated by a considerable interval from pm. 2. In both skulls m. 3 is placed a considerable distance in advance of the posterior border of the palate; in the first specimen this tooth does not extend behind the posterior border of the anterior zygomatic root; but it does so to a small extent in the second. Precisely similar dental characters are exhibited by two other crania in the British Museum (Nos. 16,380 and 40,889): the dentition of the latter is in excellent preservation, and exhibits the large inner cingulum, which appears characteristic of this form. According to Falconer and Cautley's description, the type skull differs from *H. amphibius* in the less prominent orbit; the longer post-orbital portion; the shorter and deeper pre-orbital constriction; the more concave frontals; the higher occipital surface and crest; the larger lachrymal; the shorter diastema, and the more curved line of the check-teeth. The whole skull indicates an animal rather smaller than *H. amphibius*. The dimensions of the type specimen are given in Falconer and Cautley's memoir.

Aberrant crania.—In plate LIX., figs. 3, 3a of the "F.A.S." there is figured the cranium of another Siwalik hippopotamus in the British Museum, which differs considerably from either of those described above: there is another precisely similar specimen in the same collection (No. 17,469), in which m. 3 is not fully protruded, and mm. 4 has not been shed. The figured specimen has lost the extremity of the muzzle, and a considerable portion of both zygomatic arches, but is otherwise fairly perfect. The whole of the four premolars are present; and as m. 3 is fully protruded the cranium evidently belonged to an adult individual. These two crania

¹ These are restored in the woodcut.

² Compare "F.A.S.," pl. LXII.

differ from the typical specimens by the relative position of the molar series: thus m. 3 is placed entirely behind the posterior border of the zygomatic root, and extends backwards as far as the line of the posterior border of the palate. The line of the cheek-teeth is straighter; the true molars are of a more elongated form, their length exceeding their breadth; pm. 1 is placed closer to pm. 2; while pm. 4 is of nearly the same size as pm. 3 instead of being considerably smaller. The following table exhibits the difference in the dimensions of the true molars of these specimens, and those of the two typical skulls figured in the "F.A.S."; viz. :—

		Type form		Aberrant form.	
Length of m. 1	. . . . .	1.35		1.8	1.78
Width „ „ „	. . . . .	1.75		1.5	1.62
Length „ „ 2	. . . . .	1.85	1.65	2.1	2.14
Width „ „ „	. . . . .	2.11	2.08	1.75	1.85
Length „ „ 3	. . . . .	1.8	1.0	2.1	
Width „ „ „	. . . . .	2.05	1.95		

There are several other crania in the British Museum (*e.g.* Nos. M. 491; 16,381; 16,378) exhibiting precisely similar characters; and it appears from these that the cingulum on the inner side of the true molars is less developed than in the type cranium. These crania are on the whole rather smaller than those of the type form.

Intermediate crania.—Were it not for the two specimens to be now mentioned, it would appear that the crania last described belonged to a distinct species from *H. sivalensis*; but the former exhibit such transitional characters that it appears impossible to accept this view. The two crania in question are in the British Museum (Nos. 16,379, 16,382): in the first m. 3, although entirely behind the zygomatic root, is in advance of the posterior border of the palate, and pm. 4 is of the small size characteristic of the typical skulls: while in the second m. 3 is partly behind the posterior border of the zygomatic root, and considerably in advance of the posterior border of the palate: in both the true molars are of the elongated type.

It thus seems that the wide-toothed Siwalik hippopotamus is so closely connected in certain respects by these two skulls with the narrow-toothed form, that, in the absence of other well-marked differences, it appears impossible to consider them as more than varieties, or races: it may be convenient to designate the former, or typical race as var. *latidens*, and the latter as var. *angustidens*. In provisionally regarding these two forms as races of one species it must, however, be borne in mind that no sufficient distinction can be drawn between any of the different species of the genus from the pattern of their molars, and that thus a character of much value among other genera as a means of specific distinction is lost; and it may, therefore, still be possible that there may be more than one species necessarily included in *H. sivalensis*. The large number of species by which the other genera of large Ungulata were represented in the Siwaliks renders this supposition the more probable.

In the crania represented in plate LX. of the "F.A.S." the orbit is more prominent, and the post-orbital portion of the skull relatively shorter: these

characters being most marked in the specimen represented in figs. 2, 2a, 2b, where they are accompanied by a lower occipital surface (*fig.* 2b). The transition from the typical skulls to this specimen is, however, so gradual that, in the absence of other differences, it appears impossible to draw any specific distinction on this score; but the specimens with more prominent orbits undoubtedly exhibit a marked step from the type in the direction of the *Narbada* and existing hippopotami.

Mandible.—Several specimens of the mandible are represented in plates LX., LXI. of the "F.A.S.": those in figs. 3 and 6 of the former showing the milk-dentition: a specimen of the anterior portion of the symphysis represented in plate LXI., *fig.* 7, is refigured on a smaller scale in the woodcut on page 38. The three incisors are sub-equal in size; the median pair being rather larger than either of the others: at the free edge of the mandible¹ the six teeth form an even line, but the lower part of the alveolus of *i. 2* is placed above the level of the other two alveoli.² These teeth are placed more obliquely than in *H. amphibius*, and the abraded surface is more confined to their extremities, indicating affinity to the pigs; the canines are relatively shorter and larger; and *pm. 1* is retained longer. The descending plate at the angle³ is considerably larger and deeper than in *H. amphibius*, and its anterior border is blunt and rounded, instead of curved and pointed anteriorly. The mandible of the Siwalik species is also distinguished by its longer symphysis, of which the superior surface is more deeply channelled. The line of the lower cheek-teeth and the horizontal ramus of the mandible, is markedly concave externally, instead of nearly straight.⁴ It does not appear that the lower cheek-teeth of the two forms present any characteristic points of distinction. The following table exhibits the dimensions of the mandible⁵ of *H. sivalensis* represented in plate LXI., *fig.* 5, of the "F.A.S.," compared with those of a very large fossil mandible of *H. amphibius* in the British Museum from Auvergne,⁶ *viz.* :—

	<i>H. sivalensis.</i>	<i>H. amphibius.</i>
Length of symphysis	7.1	6.8
Interval between canines	8.0	11.0
Depth at <i>pm. 1</i>	4.6	5.1
Longer diameter of canine	2.4	2.5
" " " <i>i. 1</i>	1.35	1.4
" " " <i>2</i>	1.0	
" " " <i>3</i>	1.3	0.8

Mandible of small variety.—In *fig.* 1 of plate VI. of this volume there is represented the left ramus of the mandible of a hippopotamus collected by Mr. Theobald in the Siwaliks of the Punjab, which differs somewhat from the typical mandibles of *H. sivalensis*, as is shown by the following dimensions, *viz.* :—

¹ "F.A.S.," pl. LXI., *fig.* 4.

² *Ibid.*, *fig.* 4a.

³ *Ibid.*, pl. LX., *figs.* 8, 9.

⁴ Compare "F.A.S.," pl. LXI., *fig.* 5, with Blainville's "Ostéographie," Gen. Hippopotamus, pl. 11.

⁵ B.M., No. 17,085.

⁶ The homology of the lower incisors of *H. amphibius* will be discussed in the sequel.

	Specimen.	Typical form. ¹
Depth of ramus at m. 2	4.2	4.4
Length of five last cheek-teeth	7.7	8.5
" " m. 1	1.21	1.5
Width " " "	0.95	1.3
Length " " 2	1.68	1.9
Width " " "	1.22	1.55
Length " " 3	2.2	2.82
Width " " "	1.3	1.6

These dimensions show that while the depth of the ramus is practically the same in the two specimens, there is a great difference in the absolute size of the teeth: the hinder border of the symphysis is also placed farther forward in the smaller jaw, and the true molars are proportionately slightly narrower. In the first notice of this specimen² it was thought that it might belong to *H. iravaticus*,³ but an examination of the original specimens on which that species was founded has shown that the present specimen is too large, and has too short a symphysis to belong to that form. It is not, however, improbable that it should be referred to the form which is here provisionally termed *H. sivalensis*, var. *angustidens*.

Vertebrae and limb-bones.—An extensive series of these bones are contained in the British and Indian Museums, but have never been compared with those of other species, although a large number from the former collection are figured in the "F.A.S."⁴ The following points in which some of the Siwalik bones differ from those of *H. amphibius* may be recorded:—The spinous process of the axis is higher vertically and shorter antero-posteriorly, and the odontoid process blunter and directed more upwardly. The scapula has its long diameter shorter, and its fore-and-aft borders more curved. Of the femur there are two forms, in one of which the head is very similar to that of *H. amphibius*, while in the other it is more prominent, and approaches that of the same bone in one of the Narbada species: in the former the trochlear surface for the patella is less deeply excavated, and its superior border less sinuous than in *H. amphibius*, thus indicating a lesser degree of specialization: the shaft is apparently stouter. These differences confirm the suggestion that *H. sivalensis* may really include more than one species. The astragalus (of which also there seems to be more than one form) is decidedly longer than the corresponding bone of *H. amphibius*, and thereby makes a marked step in the direction of the pigs. .

Affinities.—The long mandibular symphysis, the three pairs of incisors in each jaw, the small prominence of the orbits, and the elongated astragalus, are all characters clearly indicating that this species is of a less specialized type than the living members of the genus.

Distribution.—This species occurs in the typical Siwalik Hills, where its remains are extremely common, and continues into the western Punjab, where it is equally rare. It is unknown from Sind and Perim Island. Remains of the genus occur in Burma, but have all been referred to the next species.

¹ Taken from a specimen in the Indian Museum.

² 'Records,' vol. XV., p. 32.

³ *Vide infra*.

⁴ Plates LXIII., et. seq.

H. sivalensis by the more abrupt angle at the inferior border of the anterior extremity, and by the relatively shorter symphysis; the latter character being shown in the following table of measurements; *viz.*

	Ind. Mus. F 147	H. namadicus ¹ Brit. Mus.			<i>H. sivalensis</i> .
		1.	2.	3	
Length of symphysis		4.1	5.2	5.85	7.1
Interval between canines		7.2	9.3	9.9	8.0
Depth at pm 1		4.3	4.65	5.2	4.6
Longer diameter of canine		1.67	1.86	2.14	2.4
" " " 1 1	1.2	1.23	1.26	1.3	1.35
" " " 2	0.9	0.97	0.9	0.92	1.0
" " " 3	1.33	1.24	1.43	1.5	1.3

The complete horizontal ramus of this species is not exhibited by any of the British Museum specimens, but the highly curved outer surface of the portion remaining indicates that the ramus was relatively shorter than in *H. sivalensis*, and probably not dissimilar to that of the next species. The short symphysis distinguishes the present jaws still more markedly from *H. iravaticus*. The incisors exhibit none of the peculiarities of those of *H. hipponensis*. The distinction of the present specimens from the mandible of the succeeding species (*H. palæindicus*) will be indicated in the sequel.

The foregoing comparisons sufficiently indicate the specific distinctness of *H. namadicus* from all other known hexaprotodont forms.

Cranium.—In the "F.A.S." (pl. LVII., fig. 1, LVIII., fig. 4) two crania of Narbada hippopotami, wanting the premaxillæ, are referred to *H. palæindicus*; and a third specimen in Calcutta² was also assigned by Falconer to the same species. There is apparently, however, not the slightest reason for assigning any of these specimens to *H. palæindicus* rather than to *H. namadicus*; and it is quite probable that some, or all of them may belong to the latter. It will be better to allude to the distinctive characters of these crania under the head of *H. palæindicus*.

Distribution.—Remains which can be certainly referred to the present species have been obtained only from the Narbadas; but the old alluvium of the Jamna, and the pleistocene of the Penganga and other rivers, have yielded remains of hippopotami, which may probably be referred either to one or other, or to both of the Narbada species.

Species 4: HIPPOPOTAMUS PALÆINDICUS, Falc. and Caut.

Syn. *Tetraprotodon palæindicus*, F. and C.

History.—With the exception of the mandibles noted above as belonging to *H. namadicus*, the whole of the remains of hippopotami from the Narbadas figured in the "F.A.S." are referred to the present species; of which no description was

¹ The British Museum specimens of which the measurements are given are those figured in the "F.A.S.," pl. LVIII., 1, fig. 2 (No. 36,840) 2, fig. 3 (No. 36,838) 3, fig. 2 (No. 36,839)

² *Idea Pal. Mus.*, vol. I, p. 147.

ever published by Falconer. The only one among all those specimens exhibiting the incisors is the symphysis of the mandible represented in plate LVII., figs. 5, 5a of the "F.A.S."; which must consequently be taken as the type specimen. The only important note¹ of Falconer's in reference to the species is to the effect that it differed from *H. amphibius*, in the proportions of the lower incisors. A note was published in 1882 by the present writer² showing that *H. palæindicus* was at all events in some instances hexaprotodont.

Mandible.—The type mandible³ consists only of the symphysis, showing the complete alveoli of a central pair of incisors, and the lower halves of the alveoli of an outer pair, together with the section of the left canine. The alveoli of the outer incisors are larger than those of the inner; and in the figure the specimen has been restored as simply tetraprotodont, but it will be shown below that this restoration is most probably incorrect. A similar mandible from the Narbadas, now in the Indian Museum, was referred to this species by Falconer⁴: it comprises only a portion of the symphysis, exhibiting the lower halves of the alveoli of two pairs of incisors and of the canines.

In figure 2 of plate VI. of the present volume there is represented the symphysis of the mandible of a hippopotamus collected by Mr. C. Hackett in the Narbadas.⁵ In this specimen there remain the sections of two pairs of large and closely approximated incisors; and in the upper triangular spaces between the first and second pair there are wedged another pair of very minute teeth, evidently corresponding to the second pair of incisors ($\bar{1}2$) in *H. namadicus*. The whole form of the jaw, and the relative size of the two pairs of large incisors leaves no doubt that the specimen belongs to *H. palæindicus*. In the British Museum there are two specimens of similar mandibles (Nos. 40,893 and 41,663)⁶ from the Narbadas,⁶ acquired since Falconer's death, exhibiting a precisely similar arrangement of the incisors. The former specimen shows the symphysis, and the complete left ramus: the descending process is smaller than in *H. sivalensis*, and more like the same part in *H. amphibius*; the horizontal ramus is, however, much shorter than in either, the total length from the descending process to the extremity being only $11\frac{1}{2}$ inches, in place of 15 in an equal-sized specimen of *H. amphibius*.⁷ In the second specimen $\bar{1}2$ is smaller on the left than on the right side. In the following table the dimensions of the four specimens mentioned above are compared with those of *H. namadicus* and *H. sivalensis*; viz. —

1 "Pal Mem.," vol. I p. 147

2 'Records,' vol. XV., p. 102.

3 "F A S.," pl. LVII., fig. 5. The place where this specimen is preserved is unknown

4 "Pal. Mem.," vol. I, p. 147.

5 The specimen mentioned in the passage of the 'Records,' already cited

6 The second specimen (41,663), which was bought at Toulmin-Smith's sale, is labelled Siwaliks its general condition, and especially its imperfect state of mineralization, leaves, however, not the slightest doubt of its Narbada origin.

7 A specimen from Auvergne in the British Museum

	Type sp.	H. palwindicus.			H. namadicus.			H. sivalensis.
		I. M. F. 149.	B. M. 40,893.	B. M. 41,663.				
Length of symphysis			5 0	5·39	4·1	5·2	5·85	7·1
Interval between canine			8 2	9 3	7·2	9·3	9 9	8 0
Depth at pm. 1			4·9	5·2	4·3	4 65	5·2	4 6
Longer diameter of canine			2 26	2 35	1·67	1·86	2·14	2·4
" " i. 1	1 5	1·06	1·80	1 8	1 2	1·23	1·26	1 3
" " i. 2		0 59	0·62	0·72	0·9	0·97	0 9	0·92
" " i. 3	1 55	2·0	1·84	1 81	1·33	1·24	1·43	1·5

From the occurrence of the small i. 2 in all the three specimens in which the superior surface of the symphysis is preserved, it seems probable that this tooth was originally present in the two specimens noticed by Falconer, in which that part is wanting. The table of measurements shows that in specimens in which the depth of the mandible is the same, the symphysis is shorter in *H. palwindicus* than *H. namadicus*; and this, coupled with the larger size of the first and third pairs of incisors, and the smaller size of the second pair, indicates the specific distinctness of the two forms.¹ This is confirmed by the difference in the position of the canines, which are placed more nearly on a level with the incisors in *H. namadicus* than in *H. palwindicus*.

Besides the shorter mandibular ramus, the latter species is distinguished from *H. amphibius* by the shorter symphysis; by the equality in size of i. 1 and i. 3; and by the presence of the minute i. 2.

Cranium.—The impossibility of deciding as to whether the crania figured in the "F.A.S.,"² under the name of *H. palwindicus*, and the similar cranium in the Indian Museum so named by Falconer,³ really belong to that species, or to *H. namadicus*, or to both, has been already alluded to under the head of the latter species. The chief characters of these crania may now be briefly mentioned. They indicate an animal somewhat larger than the existing race of *H. amphibius*; and are characterised by their prominent orbits, and their general shortness: the latter feature being shown by the small interval between the posterior border of the palate and the anterior zygomatic root, as well as by the extreme shortness of the pre-orbital constriction, and the backward position of the maxillary expansion. The last molar has its posterior border placed slightly behind the free border of the palatines; which at once distinguishes these crania from those of all other species except one variety of *H. sivalensis*. In that form, however, m. 3 does not extend in advance of the posterior border of the anterior zygomatic root; whereas this is largely the case in the Narbada skulls; the Siwalik skulls are also distinguished by their considerably longer shape, and longer pre-orbital constriction; and by their narrower molars. The nasals of the Narbada skulls seem to have been shorter and wider than those of *H. amphibius*. The shortness of the Narbada skulls is a character which accords equally well with both the forms of lower jaws from that formation.

¹ Before he had an opportunity of comparing all the specimens the present writer thought they might be identical.

² Plate LVII., figs. 1, 16, LVIII., figs. 4, 16.

³ "Pal. Mem.," vol. I., p. 147.

Vertebrae and limb-bones.—Two vertebrae and several limb-bones of Narbada hippopotami are figured in the "F.A.S." under the name of *H. palawindicus*; but it is quite impossible to say whether they belong to that species or to *H. namadicus*. A very large collection of similar bones from the Narbadas is contained in the Indian Museum, but has never been described. The femur¹ has a larger great trochanter and a more prominent head than in *H. amphibius*, and the shaft of the bone is apparently longer and more slender.

Distribution.—Like *H. namadicus*, this species is only certainly known from the Narbadas; but it probably also occurs in the corresponding deposits of the other large rivers. The association of hippopotamus remains with stone implements in the Narbadas proves the coexistence of man in India with these animals, and hence Falconer's conjecture that the so-called 'water-elephant' of the early writings of India refers to a tradition of the existence of that animal may not improbably be correct.²

GENERAL REMARKS ON THE GENUS HIPPOPOTAMUS.

Generic unity of hexa- and tetraprotodont forms.—The case of *H. palawindicus*, which in its lower jaw is really a *Hexaprotodon* in process of conversion into a *Tetraprotodon*, coupled with the instance of unilateral hexaprotodontism in *H. amphibius*,³ indicates that Falconer's two subgenera should be abolished. This point being admitted there are but slight grounds for retaining the subgenus, or genus, *Cheropsis*; and accordingly all the species of hippopotamus may be referred to a single genus.

Lines of specialization.—The Indian species of the genus indicate that the specialization of the genus has advanced on two main lines; *firstly*, in the shortening and widening of the mandibular symphysis, frequently accompanied by a general shortening of the cranium and mandible; and, *secondly*, in the reduction of the number of incisors, this reduction probably occurring first in the lower jaw, and being accompanied by the largely increased size of one or more of the remaining pairs of teeth. These features are apparently also accompanied by an increase in the size of the canines.

The most primitive form of mandible is exhibited by *H. iravaticus*, in which the long narrow symphysis, the six small incisors, and the small canines, indicate an animal much closer to the pig than any other species of which the mandible is known. The next step is *H. sivalensis*, in which the symphysis is considerably shorter, although the incisors still preserve their small size. The third step is *H. namadicus*, in which the symphysis has still more decreased in length, while $\bar{i}2$ has become slightly smaller, and is thrown more or less above the line of the other two. The fourth step is exhibited by *H. palawindicus*, in which the symphysis is shorter than in any other form, while $\bar{i}1$ and $\bar{i}3$ have increased enormously in size at the expense of $\bar{i}2$, which becomes wedged in between the other two. It is highly

¹ "F.A.S.," pl. LVIII

² *Ide* "Pal. Mem.," vol. II, pp. 640-1.

³ *Ide supra*, p. 37

probable that these four species represent the actual line of descent in which these modifications have been accomplished.

Another branch, which may have taken origin from the same hexaprotodont stock, is represented by *H. amphibius*, in which the symphysis is shorter than in *H. sivalensis*, although longer than in the Narbada hippopotami: in this form the lower incisors are reduced to two, of which the inner is very large, and the outer very small. Finally in *H. liberiensis* another tooth, probably corresponding to the small outer incisor of *H. amphibius*, has likewise disappeared. The longer symphysis of *H. amphibius* indicates that this species should not be regarded as the direct descendant of either of the Narbada hippopotami. The large size of i. 3 in *H. palamindicus* still more strongly confirms this view in respect of that species.

Homology of incisors—In the case of *H. palamindicus* it is proved that i. 2 is the tooth which is about to disappear; and from the constancy of the order in which the terminal cheek-teeth tend to disappear among the more specialized mammals, it may be assumed with a high degree of probability that it is the same tooth which is wanting in the mandible of *H. amphibius*. It is unfortunate that the upper incisive series of *H. palamindicus* is unknown, but from the disappearance of homologous cheek-teeth in the upper and lower jaws of mammals generally, it is probable that it is i. 2 which has disappeared in *H. amphibius* and the other tetraprotodont forms. This inference is confirmed by certain observations recorded by Prof. P. Albrecht,¹ which lead to the conclusion that it is the same tooth which has disappeared in man, and, therefore, in other mammals.²

The small size of i. 3 in *H. amphibius* renders it probable that it is this tooth which has disappeared in *H. liberiensis*; and it would, therefore, seem that in those mammals where the incisors are reduced to a single pair, that pair corresponds to the first of the typical series. From the instance of *H. liberiensis* it also seems that the disappearance of each pair of incisors commences in the lower, sooner than in the upper jaw; this arrangement corresponding with that which obtains in the case of the cheek-teeth among mammals generally.

If these conclusions hold good the two upper incisors which are occasionally developed in *Rhinoceros*³ will be respectively the first and third of the eutherian series; the single tooth that is normally present being the first. It will also be evident that the two pairs of lower cutting teeth which are frequently present in that genus, will be respectively the inner incisor and the canine; since if they were both incisors, as was formerly considered to be the case, the number of lower incisors would exceed the upper; which is apparently never the case among the eutherian

¹ "Sur les 4 Os Intermaxillaires, le Bec-de-L'arc, et la Valeur Morphologique des Dents Supérieures de l'Homme," Brussels, 1883

² The instances of *Ursus tatus* in which i. 1 is wanting, and *Badassus* in which i. 3 has disappeared, are exceptions, but as the space for this tooth persists in the former, and the dentition of the species is altogether abnormal, while in the latter the disappearance of i. 3 is clearly due to the large canine, these exceptions need not invalidate the rule.

³ *Vide* "Journ As Soc Beng," vol XLIX pt II, p 136, pl VII, fig 1 these teeth are numbered i. 1 and i. 2 in the figure.

mammals, except in special instances like those noticed above. From the presence of four incisors in some Metatheria Prof. Albrecht comes to the further conclusion that i.3 of the eutherian series really corresponds to i.4 of the metatherian series; the first reduction in number taking place by the suppression of i.3 of the metatherian series.

FAMILY II.: *SUIDÆ*.

Extent.—For palæontological purposes it seems best that the present family should be taken to include the recent family *Dicotylidæ*.¹ It is abundantly represented in the fossil state both in the New and Old Worlds: all the species found in the former are, however, more or less closely related to *Dicotyles*; the typical swine having apparently been always confined to the Old World. The Siwalik representatives of the family comprehend the genera *Sus*, *Hippohyus*, *Sanitherium*, and *Hyotherium*; which will be treated of in this order.

GENUS I.: *SUS*, Linn.

Including² *Porcula*, Hodgs.; and *Potamochærus*, Gray.

Extent, dentition, etc.—The dentition of the existing species of *Sus* is so well known that it is unnecessary to describe it. It comprehends the full eutherian series; but in some fossil forms the first premolar in both jaws is usually or always absent. In the African river-hogs (*Potamochærus*) the anterior premolar is also absent in both jaws, the talon of the last molars is smaller than in the more typical pigs, and the structure of all the cheek-teeth is somewhat less complex.³ In some of the miocene and pliocene forms the latter features are still more pronounced, and it thus becomes very difficult to draw any distinction between *Sus* and *Hyotherium*, and impossible to draw any between *Sus* and *Potamochærus*; so that for palæontological purposes the two living species of the latter may be included in the former. It has recently been shown⁴ that the genus *Porcula*, Hodgs., should be merged in *Sus*. *Babirussa*, besides its enormously developed canines, is readily distinguished by the early loss of the outer upper incisors, and the two first premolars in each jaw: the talons of the last molars are also smaller, and the four main columns of the molars more distinct than in existing species of *Sus*; these teeth being, moreover, relatively narrower. In cases where only the hinder cheek-teeth of some of the more generalized fossil-forms are known it would, however, be difficult to distinguish between *Sus* and *Babirussa*.

Recent species.—There is still a great amount of uncertainty as to the number of

1 In vol. II. of this work (p. 146) the two families are still maintained. The genus *Heterohyus*, Gerv. ("Zool. et Pal. Franç.," pl. XXXV., fig. 14), was then included in the *Suidæ*: from its resemblance to *Aphelotherium* it should, however, very probably be referred to the *Pachysimia*.

2 It is needless to allude to the numerous genera into which *Sus* was divided by Gray.

3 There is, however, an almost complete transition in this respect among living pigs from *S. scrofa* to *Potamochærus*.

4 Garson, 'Proc. Zool. Soc.,' 1883, p. 413, *et. seq.*

existing Asiatic species of the genus. Rolleston¹ regards *S. cristatus*, *S. vittatus*, and *S. leucomystax* as forming a closely allied group, and thinks it highly probable that the two last may be all but identical; he also considers *S. andamanensis*, *S. papuensis*, and *S. timorensis* as another group intimately related to the first. Prof. Rüttimeyer² unites *S. leucomystax* and *S. vittatus*, and regards the *S. andamanensis* group as smaller races of the same. Prof. Forsyth-Major³ thinks that (excluding *Potamochoerus* and *Porcula* (*S. salvanius*)) there are but four existing species, viz., *S. scrofa*, *S. barbatus*, *S. verrucosus*, and *S. vittatus*; the latter including *S. cristatus*, *S. leucomystax*, the *S. andamanensis* group, and some other forms. All are agreed in regarding *S. celebensis* as intimately related to, or identical with, *S. verrucosus*.

S. barbatus is readily distinguished by its elongated cranium, and the extremely short m. 3. *S. scrofa*, according to Rolleston, is distinguished from *S. verrucosus* and the *S. vittatus* and *S. andamanensis* groups, by the form of the lachrymal, and the relatively long facial portion of the cranium. In males of *S. cristatus* the talon of m. 3 is more complex than in *S. scrofa*, and in most instances the length of m. 3 exceeds that of m. 1, m. 2, and in all examples that the writer has seen the length of m. 3 exceeds that of m. 1 and m. 2.⁴ In *S. vittatus* m. 3 is normally shorter than in *S. cristatus*; its length, especially in the lower jaw, in all typical examples⁵ that have come under the writer's notice being less than that of m. 1, m. 2. There may be exceptions, but these points are generally characteristic of the two forms. In *S. andamanensis*⁶ m. 3 has a still smaller talon, and its length is still less in proportion to that of m. 1, m. 2. On these grounds the present writer is inclined to continue to apply separate names to the Indian *S. cristatus*, the Javan (etc.) *S. vittatus*, and the smaller *S. andamanensis*, even if certain forms indicate a more or less complete transition between them.⁷ In *S. verrucosus* the length of m. 3 is usually about the same as that of m. 1, m. 2. *S. salvanius* is distinguished from all by its diminutive size. The river-hogs comprise *S. africanus* of S., and *S. porcus* of W. Africa: the skulls of these species are readily distinguished by the great development of the protuberance above the canine.

Fossil species.—There is great difficulty in deciding on the number of European fossil species; and the following list⁸ which comprehends the best-defined forms must, therefore, be regarded as purely provisional. The confusion in the synonymy is, indeed, so great, that the only way to arrive at a thoroughly satisfactory conclusion

¹ 'Trans. Linn. Soc.' Zool., ser. 2, vol. I., pp. 251-286 (1877).

² 'Verh. nat. Ges. Basel,' vol. VI., pt. 3 (1877).

³ Carus' 'Zoologischer Anzeiger,' vol. VI., pp. 295-300 (1883).

⁴ In one specimen in the Brit. Mus. (No. 1716 S.) m. 3 is abnormally short, its length being less than that of m. 1, m. 2: m. 3 is, however, longer than m. 1, m. 2. The same seems to be the case with the male skull figured by Rolleston. These specimens are, therefore, exceptions to the general rule given on page 56.

⁵ No. 1362 B., British Museum., is an exception, but this specimen not improbably belongs to *S. verrucosus*.

⁶ Rolleston, *op. cit.*, p. 262, pl. XLIII., fig. 8.

⁷ The writer would not be deterred from applying distinct names to two well-marked forms which are more or less connected by other forms, for it is evident that if such connections be wanting this is merely due to their extinction.

⁸ It should be observed that here, as elsewhere, the references do not always refer to the original descriptions of the different species, but merely to memoirs where good figures or descriptions may be found.

would be to compare all the type specimens. The most doubtful species are indicated by an asterisk. The living *S. scrofa* occurs in the Forest-bed of the Eastern Counties;¹ and *S. antiquus* and *S. palæochærus* have been recorded from the Red Crag.

1. *SUS ANTIQUUS*, Kaup.² Up. miocene, Eppelsheim.

A species frequently larger than *S. erymanthus*, and with relatively larger canines, and thicker lower premolars: $\overline{pm.1}$ is present in some instances.

*2. *SUS ARVERNENSIS*³ (Cr. and Job.). Up. pliocene, France.

Aper arvernensis, Cr. and Job.

An imperfectly determined species, smaller than *S. scrofa*.

*3. *SUS CHÆROIDES*,⁴ Pom. Up. miocene, Europe.

S. africanus (larvatus)? Blain. • ? *S. antediluvianus*, Kaup (*in parte*).

A species smaller than *S. scrofa*; said to resemble *S. africanus*; it is suggested by Gervais⁵ that it may be the same as *S. antediluvianus*⁶ or *S. palæochærus*: the former species as being an extremely uncertain one is provisionally included, although Kaup's name has the priority. The last molars are relatively short.

4. *SUS CHÆROTHERIUM*, Blain.⁷ Mid. miocene, France.

S. (?) doati, Lart.

S. simorreensis, Lart. (*teste* Gervais).

A species varying in size, according to Gervais, from that of *S. scrofa* to *S. erymanthus*: its canines are relatively large, and its molars approach those of *Hyootherium*.

5. *SUS ERYMANTHIUS*,⁸ Roth. and Wagn. Pikermi group.

A species considerably larger than *S. scrofa*, with extremely small canines: $\overline{pm.1}$ generally absent in both jaws.

*6. *SUS LOCKHARTI*,⁹ Pom. Mid. miocene, France.

? *S. belsiacus*, Gerv.

An ill-defined species of about the same size as *S. palæochærus*, with which its molars agree in general characters: these, according to Prof. Gaudry, approach those of *Hyootherium*. It is considered probable by Gervais¹⁰ that the so-called *S. belsiacus* is the young of this species.

*7. *SUS MAJOR*,¹¹ Gerv. Mt. Lebéron group.

A species at least as large as *S. erymanthus*, from which it is only distinguished by the absence of the protuberance over the upper canine: $\overline{pm.1}$ absent in both jaws: it is regarded by Prof. Gaudry as being probably merely a race of *S. erymanthus*.

8. *SUS PALÆOCHÆRUS*,¹² Kaup. Up. miocene, Eppelsheim.

An imperfectly determined species, with which *S. chæroides* should possibly be united.

The molars are smaller than those of *S. scrofa*: in the small talons of the last of the series, and in the stout premolars it approaches *S. porcus*.

¹ It should be observed that here and elsewhere the present writer follows Prof. Boyd-Dawkins ('*Quart. Journ. Geol. Soc.*,' vol. XXXVI., p. 395) in regarding the Forest-bed as pleistocene.

² "Beitrage," pt. IV., pls. IV., V. "Oss. Foss. d. Mus. d. Darmstadt," p. 8, pl. VIII.

³ Blainville, "Ostéographie," Genus *Sus*, pl. IX. ⁴ *Ibid.*, and Pom., cited below. ⁵ "Zool. et Pal. Franç.," p. 180.

⁶ This species was identified by Kaup ("Beitrage," pt. IV., p. 12, pl. VI, figs. 4, 5) with *Hyootherium sammeingsi*; and this identification is accepted in part by Peters: the lower jaw figured by Kaup (*op. cit.*) is quite different from that of *H. sammeingsi* figured by Peters ($\overline{pm.1}$ being small in the former and large in the latter), and seems to belong to *Sus*.

⁷ *Op. cit.* *Chærotherium dupui*, Lart., is identified by Gervais in one place (*op. cit.*, p. 179) with this species, and in another (p. 185) with *Chæromorus mammilatus*.

⁸ Gaudry, "Animaux Foss. et Géol. de l'Attique," p. 235, pls. XXXVII.-IX.

⁹ Pomol, 'Bibl. univ. d. Genève Archiv.,' vol. VIII., p. 159.

¹⁰ *Op. cit.*, p. 180, pl. XXXIII., fig. 7.

¹¹ Gaudry, "Animaux Foss. du Mt. Lebéron," p. 42, pls. VII., VIII.

¹² "Beitrage," pt. IV., pl. VI.

9. *SUS PRISCUS*, M. de Ser.¹ Pleistocene, France.

A species about the size of *S. scrofa*, with which it agrees in dentition; its skull is, however, more like that of *S. africanus*.

10. *SUS PROVINCIALIS*, Gerv.² Low. pliocene, Montpellier.

Larger than *S. scrofa*, with m. 3 like that of *S. africanus*, with which it was identified by De Blainville: it has small canines, and four lower premolars.

11. *SUS STEINHEIMENSIS* (Fraas³). Mid. miocene, Germany.

Chæropotamus steinheimensis, Fraas.

A species considerably smaller than *S. scrofa*, referred to the present genus on the authority of Prof. Gaudry⁴: the molars are apparently not unlike those of living swine.

12. *SUS STROZZI*,⁵ Menegh. Up. pliocene, Italy.

A species stated by Prof. Forsyth-Major to present affinities to *S. verrucosus*.

13. *SUS VALENTINI*, Fillhol.⁶ Miocene, France.

Characterized by the extremely short talon of m. 3; the whole length of this tooth being less than that of m. 2. The species is apparently somewhat smaller than *S. andamanensis*.

Sus (?) *mastodontoides*, Blain., is probably a Sirenian, while *S.* (?) *lemuroides*, Blain., may belong to the Pachysimia. Most of the other forms which have been referred to *Sus* belong to *Hypotherium*, or allied genera.

Distribution.—The genus, both in the recent and fossil condition, is entirely confined to the Old World, over which it appears to be pretty generally distributed. In time, according to Prof. Gaudry,⁷ it made its first appearance in the middle miocene (stage of Montabuzard).

Species 1: *SUS GIGANTEUS*, Falc. and Caut.

History of fossil Indian species.—The earliest notice of the occurrence of fossil swine in the Siwaliks seems to be one published in 1835 by the late General (then Lieut.) Sir W. E. Baker⁸; in which the lower jaw of a species considerably larger than the existing Indian wild-boar was described and figured. In the following year a fuller notice was published by Messrs. Baker and Durand,⁹ in which a nearly complete skull of a female and several upper and lower jaws were described and figured. It was therein stated that the authors had evidence of the existence of two species of Siwalik swine; one considerably larger, and the other smaller than

¹ "Récherches dans les Cavernes de Lunel-Viel," p. 134, pl. XI. (Montpellier, 1839).

² *Op. cit.*, p. 177, pls. III., XXII. Ratimeyer, 'Verhand. nat. Ges. Basel,' vol. I., p. 517, *et. seq.* (1857)

³ "Die Fauna von Steinheim," p. 22, pl. V. (Stuttgart, 1870). ⁴ "Animaux Foss. du Mt. Lobéron," pp. 45-6.

⁵ Forsyth-Major, 'Proc. Verb. Soc. Tosc. Sci. Nat.,' vol. II., 1881, p. 22 the writer has not seen a full description of this species.

⁶ 'Bull. Soc. Philom.,' vol. VI, 1882, p. 123.

⁷ "Les Enchainements—Mam. Tert.," p. 5. It is possible that the subsequently described *S. valentini* may belong to a lower stage.

⁸ 'Journ. As. Soc. Beng.,' vol. IV., p. 568, pl. XLVII., fig. 20.

⁹ *Ibid.*, vol. V., p. 661, pls. XXXV. and XLIV.

S. cristatus. No specific name was, however, assigned to either form, although both were considered specifically distinct from the living swine of India. A large number of the remains of Siwalik swine were subsequently figured by Falconer and Cautley in the "Fauna Antiqua Sivalensis";¹ and were referred to three species, namely, *S. giganteus*, *S. hysudricus*, and *S. (Hippohyus) sivalensis*. No descriptions of these species were, however, ever published, and their identification accordingly rests solely on the figures. The remains figured in that work under the first name belong to at least two species; and it appears that the first published occurrence of the name is in that work. A skull of a large pig from the Siwaliks was briefly mentioned at a later date by the present writer under the first name, but is referred below to a new species.

Type cranium.—The specimen which the writer thinks it best to take as the type of the present species is the very perfect cranium from the Siwalik Hills represented ($\frac{1}{3}$) in plate LXIX., figs. 1, 1a, 1b, 1c, of the "F.A.S.," and now preserved in the British Museum (No. 15,385). It is noticed in the description of the plate in the following words, *viz.*:—"The zygomatic arches are perfect. There are three molars on either side, and also the last premolar. The specimen is broken off in front of the last premolar. The extreme distance between the zygomata is much greater than in *S. cristatus*. The sub-orbital foramina are large, and the bone is deeply channelled in front." The most striking feature in the skull, which is considerably larger than that of *S. cristatus*, is the excessive width of the zygomatic arches; the anterior root of which bends out very suddenly from the maxilla. The vertical height above m. 3, and at the occiput, is considerably greater than in *S. cristatus* and *S. scrofa*; and the facial profile is straighter than in the former, and ascends more rapidly towards the occiput than in either. The temporal fossæ encroach much more extensively on the parietals, making the superior surface of those bones at the pre-occipital contraction much narrower. The orbits are relatively smaller; and the palate extends much farther behind m. 3 than in either of the two living species. The fronto-parietal region is markedly convex, the concavity in front of the orbit being deep and broad behind: and the complete skull must evidently have been relatively short, and, therefore, very different from that of *S. scrofa*. The molars of this specimen are much worn; and their distinctive characters will be noticed below. The great zygomatic width of this specimen indicates that it probably belonged to a male; while the worn condition of the molars shows that it belonged to a very old individual. It probably indicates a full-sized example of the species.

Second specimen.—In figs. 2, 2a of the same plate of the "F.A.S." there is represented ($\frac{1}{3}$) the anterior portion of another Siwalik cranium in the British Museum (No. 16,166), showing the last five cheek-teeth in a less worn condition. This specimen agrees very closely in general contour with the last: the zygomatic arches are, however, slightly less prominent, and the molar series somewhat longer: the latter point causing the prolongation of the palate behind m. 3 to be somewhat less.

¹ Plates LXIX. .LXXI.

These slight variations are not, however, more than those due to differences in the age or sex of the specimens. This specimen, although the tip of the nasals is wanting, shows that the facial portion was relatively shorter in comparison with the fronto-parietal portion than is the case with *S. scrofa*; thereby indicating affinity with *S. cristatus* and its allies, and showing that the cranium is of quite a different type from that of *S. barbatus*.

In the following table the dimensions of the two specimens¹ described above are compared with those of a male skull of *S. cristatus* in the writer's possession; viz.:—

	S. giganteus.		S. cristatus.
	No. 15,385.	No. 16,166.	
Extreme zygomatic width	8.5		6.2
Width at post-orbital processes	5.1		4.25
„ „ infra-orbital foramina		2.2	2.2
„ „ narrowest part of parietals	1.08		1.8
Height of occiput	6.55		5.1
„ „ foramen magnum	0.9		0.77
Width „ „ „	1.0		0.8
Long diameter of condyle	1.6		1.2
Interval between foramen magnum and palate	3.8		3.25
Height at infra-orbital foramen	5.4	5.0	3.9
Width of palate posteriorly	1.7	1.6	1.3
„ „ „ anteriorly	1.5	1.4	1.35
Greatest diameter of orbit	1.35		1.6
Length of three true molars	3.2	3.7	2.9
„ „ four last cheek-teeth	3.8	4.25	3.42
„ „ five „ „ „		5.1	3.95
Width of intermolar space at m. 2	1.4		1.41

The remarkable narrowness of the intermolar space in the fossil form is well exhibited by these dimensions.

Upper dentition.—The right upper cheek-dentition of the second of the two skulls is represented of the natural size in plate XI., fig. 2 of the present volume.² It is in a well-worn condition, and, therefore, indicates a fully adult animal; and agrees precisely with the dentition of the type cranium. The talon of m. 3 is comparatively short; and is more like the corresponding part of the tooth of *S. barbatus* and *S. vittatus* than that of *S. cristatus* and *S. scrofa*. The crowns of the molars are relatively low, and the pattern formed on their worn surfaces is comparatively simple: the length of m. 3 slightly exceeds the united lengths of the two preceding teeth; and the whole of the molars are relatively wider than in *S. cristatus*, and other Asiatic pigs. The last premolar (pm 4) is relatively short antero-posteriorly, but this may be an accidental character: both its inner and outer halves are relatively largely developed. The penultimate premolar (pm. 3) is relatively a much wider and stouter tooth than in existing pigs; the width of its anterior portion being nearly the same as that of m. 1, instead of very much less. This unusual width is caused by the great development of the outer moiety (*a*) of

¹ The dimensions of these specimens are taken, with some corrections, from those given in the "Palæontological Memoirs."

² Also represented of half the natural size in pl. LXIX., fig. 2b of the "F.A.S."

the tooth, which forms a stout elongated cone, instead of a flattened ridge as in existing Asiatic pigs.

In plate LXXI., fig. 12 of the "F.A.S." there is represented a fragment of a maxilla of a large Siwalik pig, now in the British Museum, containing the three true molars in a rather earlier stage of wear than those of the last specimen. The characters of these teeth are precisely similar to those of the latter, although their size is slightly less: the length of m. 3 being very nearly equal to that of the two preceding teeth. There can be no hesitation in referring this specimen to the present species. A fragment of another maxilla, containing pm. 4 and m. 1, represented in fig. 16 of the same plate, and likewise in the British Museum, may in all probability be referred to the same species: pm. 4 is here of average length, but has its inner moiety much more developed than in existing Asiatic pigs.

The following table exhibits the dimensions of the cheek-teeth of the two crania, and the first of the two maxillæ: the figures in the first column refer to the type cranium, those in the second to the cranium of which the dentition is represented in plate XI., fig. 2, and those in the third to the detached maxilla. The fourth column gives the corresponding dimensions of the cheek-teeth of *S. cristatus*; *vis.*:—

		<i>S. giganteus.</i>			<i>S. cristatus.</i>
		3.2	3.75	3.2	
Length of three true molars	.	.	.	.	2.9
" " m. 1 and m. 2	.	.	1.72	.	1.45
" " pm. 4	.	0.7	0.7	.	0.52
" " "	.	0.9	0.8	.	0.55
Length " m. 1	.	0.62	0.7	.	0.62
Width " " "	.	0.82	0.92	0.76	0.6
Length " " 2	.	0.91	1.16	1.0	0.84
Width " " "	.	1.08	1.0	0.9	0.7
Length " " 3	.	1.7	1.9	1.6	1.58
Width " " "	.	1.21	1.22	1.0	0.82

These dimensions clearly show the proportionately greater width of the molars of the fossil, when compared with those of the living form. As there is another palate specimen in the British Museum, in which the teeth are similar to those of the type cranium, it may be safely assumed that the dimensions given represent the average size of the cheek-teeth of the species.

Mandible.—As is always the case where there are several allied species of a genus to deal with, there is some difficulty in assigning its proper mandible to the present species. Several Siwalik mandibles are figured in the "F.A.S." under the name of *S. giganteus*, but they will all be shown in the sequel to belong to other species. It may be observed that the following points occur in the upper and lower dentition of existing species of pigs, which may be taken as guides in associating fossil specimens of the upper and lower dentition:—*Firstly*, the pattern on the worn surface of the upper and lower teeth is the same in the same species; *secondly*, the relative degree of development of the talon of the last molar is the same in the upper and lower jaws, although this part is actually larger in the latter; *thirdly*, m. 2 is slightly longer and considerably wider than m. 2; and, *fourthly*, that where the

length of $\overline{m.3}$ exceeds, or is equal to, the united lengths of the two preceding teeth, the same holds good with regard to the proportionate length of $\overline{m.3}$ and the united lengths of the two preceding teeth. Similarly where the length of $\overline{m.3}$ is less than that of the two preceding teeth, the same relation, although sometimes in a less marked degree, prevails in regard to the length of the corresponding lower teeth.¹

The mandible represented in plate XI., fig. 1 of the present volume was collected by Mr. Theobald in the Siwaliks of the village of Asnot, in the Punjab; and from the structure of the cheek-teeth and the section of the canine evidently belongs to a species of *Sus* of large size. The extremity of the symphysis has been broken away, but the section of the incisors and canine still remains: the latter indicates a tooth of large size, with the characteristic ridge on the external surface; and from the large size of this tooth the specimen may be safely referred to a male individual. The whole of the four premolars were originally present, but have been much damaged; only a portion of the crowns of the two last teeth of this series now remaining: $\overline{pm.1}$ is separated by a considerable interval from $\overline{pm.2}$. The true molars of the left side are well preserved; and are in a medium condition of wear. In the following table the dimensions of this specimen are compared with those of a male mandible of *S. cristatus*; viz.:—

	Specimen.	<i>S. cristatus</i> .
Height of ramus at $\overline{m.2}$	3.4	2.0
Vertical height of symphysis at canine	3.0	2.1
Width of intermolar space at $\overline{m.2}$	1.45	1.55
Length of three molars	3.72	3.1
„ „ six last cheek-teeth	6.6	4.6
„ „ $\overline{m.1}$ and $\overline{m.2}$	1.85	1.45
Interval between $\overline{pm.1}$ and $\overline{pm.2}$	0.9	0.5
Length of $\overline{pm.1}$	0.54	0.29
„ „ „ 2	0.77	0.51
Width „ „ „	0.31	0.28
Length „ „ 3	1.19	0.57
Width „ „ „	0.79	0.3
Length „ „ 1	0.99	0.6
Width „ „ „	0.9	0.4
Length „ $\overline{m.1}$	0.72	0.65
Width „ „ „	0.7	0.59
Length „ „ 2	1.1	0.88
Width „ „ „	0.9	0.6
Length „ „ 3	1.9	1.65
Width „ „ „	1.09	0.7
Longer diameter of canine	1.22	0.91

It will be seen from these dimensions that $\overline{m.1}$ and $\overline{m.2}$ of the fossil are relatively wider than in the recent jaw; and that although the length of $\overline{m.3}$ in the former exceeds the united lengths of the two preceding teeth, yet that such excess is relatively less than in the latter. The same points distinguish the upper jaw of *S. giganteus*; and if the dimensions of the two series of lower teeth given above be compared with those of the upper molars of *S. giganteus* figured in plate XI., and those of *S. cristatus* given in the last column of the table on page 55, it will be

¹ These comparisons, as is noted below, should always be made between teeth in nearly the same stage of detrition.

found that the upper and lower teeth of the two fossil jaws bear the same proportion to one another, as obtains between the corresponding teeth of the existing species. The molar teeth of the mandible under consideration agree, moreover, in absolute size with those of *S. giganteus* figured in plate XI., the length of m. 2 being almost exactly the same size in both (1.16, 1.1); while in the lower jaws the pattern formed on the worn surfaces of the molars is as simple, and the crowns of the molars are as low as in the upper jaw: the length of m. 3 also exceeds to a small extent the united lengths of the two preceding teeth; and the talon of the former tooth is of relatively simple structure. The fossil lower jaw also agrees with the cranium of *S. giganteus* in having the intermolar space absolutely less than in the smaller jaws of *S. cristatus*. All these points indicate very strongly that the mandible under consideration belongs to the same species as the crania described above; and when to these is added the peculiar structure of the premolars of the former the probability that this association is correct is rendered very strong indeed. An inspection of fig. 2 of plate XI. will show that the mandible under consideration exhibits some very remarkable features in the structure of its premolars, which are unknown in any other species of the genus. Thus the first and second of these teeth, judging from their broken bases, appear to have been similar to those of other pigs: pm. 3, however, in place of being a narrow cutting-tooth inserted only by two fangs, as is the case in existing pigs, has a stout triangular crown with the apex situated anteriorly, inserted by three distinct fangs, as is well seen in the left ramus. The fourth premolar (pm. 4) is also a much wider tooth than in existing pigs; the width of its posterior half considerably exceeding that of m. 1, instead of being narrower: it is probable that the two hind fangs of this tooth were more distinctly separated than in existing pigs. Now since it has been shown that pm. 3 and pm. 4 of *S. giganteus* are wider and stouter than the corresponding teeth of most existing pigs, it is pretty certain that the homologous lower teeth of that species would likewise have been abnormally large. It is true that the two upper premolars of *S. giganteus* represented in plate XI. are proportionately rather too short to correspond exactly with the homologous teeth of the present specimen; but it is probable that pm. 4 is abnormally short in that cranium, and it is quite possible that the specimen may belong to a female individual. The rami of the present mandible indicate an animal of great strength of jaw; which is also a character in harmony with the characters of the type cranium: the inferior border of the symphysis of the mandible seems to have been much elongated. Should future discoveries eventually prove that the provisional reference of the mandible under consideration to *S. giganteus* is incorrect, it will then follow that that specimen belongs to a new species.

The structure of the two last premolars of the present specimen is precisely similar to that of the corresponding teeth of *Tetraconodon*¹; the only difference being that their size in relation to that of the true molars is proportionately much less.

¹ *Ide supra*, vol. I, pl. X

The simple structure of the true molars of the present specimen is also but one step in advance on *Tetraconodon*, where the columns form completely distinct cones.

Specific distinctness and affinities.—The foregoing comparisons and measurements have sufficiently indicated the specific distinctness of the present form from *S. scrofa*, *S. cristatus*, and *S. barbatus*; and it cannot be identified with any other existing Asiatic species; from all of which, putting aside mandibular characters, it is distinguished by its superior size, and the relatively large development of pm. 3 and pm. 4. In the African *S. porcus* the hinder premolars are stouter than in *S. scrofa* and existing Asiatic pigs, but pm. 3 is narrower than in the crania under consideration; and the last molar shorter in proportion to the preceding teeth. In the form of the cranium the fossil has been shown to be nearer to *S. cristatus* and its allies than to *S. scrofa*: the species coming nearest to it in this respect being *S. vittatus*,¹ in which the shortness and height of the cranium are especially well marked, the palate extending a considerable distance behind m. 3, and that tooth having a rather shorter talon than in *S. cristatus*. In both the recent and fossil crania the form of the pre-orbital concavity is very similar, and the anterior border of the orbit extends as far forwards as the middle of m. 3. The recent cranium, besides its inferior size, is readily distinguished by its less prominent zygomatic arches, smaller occipital height, and smaller pm. 3 and pm. 4.² In *S. verrucosus* and *S. celebensis* the cranium is somewhat similar in shape to that of *S. vittatus*, but the length is generally proportionately greater to the height, and the talons of the last molars are of rather more complex structure.³ The characters of the inferior premolars of the mandible provisionally referred to the present species are quite distinct from those of any existing species.

Of the fossil species given on the list on pages 51, 52, the only ones which can compare in size with the present form are *S. chærotherium*, *S. provinciælis*, *S. antiquus*, *S. erymanthus*, and *S. major*. The two latter,⁴ which Prof. Gaudry thinks are probably merely varieties of the same species, are readily distinguished by the form of the cranium,⁵ which is of an elongated type somewhat like that of *S. barbatus*,⁶ with the orbit entirely behind m. 3, and with a very slight parietal constriction. The upper molars of the Siwalik species are, as Prof. Gaudry remarks,⁷ relatively wider; while in the European species the length of m. 3 is considerably less than the united lengths of the two preceding teeth: pm. 3 of the latter is also much narrower than in the Siwalik species. The mandible provisionally referred to the latter is distinguished from the mandibles of the European forms by its much larger canine, the presence of pm. 1, and the peculiar form of pm. 3 and pm. 4; as well as by the length of m. 3 exceeding the united lengths of the two preceding teeth, the reverse condition prevailing in the European mandibles, although less markedly in the specimen figured under the name of

¹ Skull figured by Gray, "Hand-List of Edentate, Thick-skinned, and Ruminant Mammals in the British Museum," pl. XXIV., fig. 3 (*Antilocapra vittatus*).

² In *S. vittatus* the length of m. 3 is usually less than that of m. 1 and m. 2.

³ Rolleston, *op. cit.*, pp. 267, 274.

⁴ *Vide* Gaudry, "Animaux Foss. et Géol. de l'Attique," p. 235, pls. XXXVII.-IX.; and "Animaux Foss. du Mt. Lebéron," p. 42, pl. VIII.

⁵ Compare "F.A.S.," pl. LXIX., figs. 1, 16, with Prof. Gaudry's figures.

⁶ Rolleston, *op. cit.*, pl. XLIII., fig. 7.

⁷ "Animaux Foss. et Géol. de l'Attique," p. 242.

S. erymanthus than in that named *S. major*. In *S. antiquus*,¹ which is apparently only known by the mandible, the length of $\overline{m.3}$ is less than the united lengths of the two preceding teeth, and it is, therefore, to be presumed that the same relation held good in the upper jaw: the lower molars are of the elongated form of those of *S. erymanthus*. The hinder lower premolars of *S. antiquus* are quite different from those of the mandible figured in plate XI.; and it is probable, as will be shown under the head of the next species, that the canine was relatively smaller. *S. provincialis*² is of smaller size, and is readily distinguished by the extreme smallness of the talon of $\underline{m.3}$: in the lower jaw the united length of $\overline{m.1}$ and $\underline{m.2}$ exceeds that of $\overline{m.3}$, and the last premolars are not of the peculiar form of those figured in plate XI. The molars of *S. cherotherium*³ are frequently of much smaller size, and the columns are of more simple structure.

It thus appears, irrespective of the question whether the mandible be rightly associated with the crania, that the present large Siwalik pig cannot be identified with any other named form, and is, therefore, entitled to specific distinction. The remarkable resemblance existing between its cranium and that of the Javan *S. villatus*, coupled with the fact that the talon of the last molar of the latter is rather less complex than in *S. cristatus*, and that, according to Prof. Rüttimeyer, its molars are relatively wider, and its hinder premolars decidedly stouter than in *S. scrofa*, renders it not improbable that the Javan species may be the lineal descendant of the larger Siwalik species. The existing species has lost the wide $\underline{pm.3}$ characteristic of the latter; as well as, if the fossil mandible be rightly determined, the large and wide last lower premolars. Force is added to this suggestion from the circumstance that other Siwalik mammals find their existing representatives in the Malayan region: thus *Hemibos* is represented by the living anoa of Celebes, *Palaeopithecus* by the orangs of Borneo, and *Rhinoceros sivalensis* by the small one-horned rhinoceros of Java and the eastern side of the Indian region.

The check-dentition of the mandible figured in plate XI. indicates very clearly that the species of *Sus* to which it belonged was intimately related to *Tetraconodon*; and that the two had a common origin at a comparatively recent geological epoch.

Distribution.—If the specimens described above be rightly associated, the range of the present species extended from the typical Siwalik Hills to the Punjab.⁴

Species 2: *SUS TITAN*, n. sp., *nobis*.

History.—The name of this species is mentioned here for the first time; the specimens on which it is founded having been hitherto referred to the last species.⁵

¹ Kaup, "Beiträge," pt. IV, pls. IV, V.

² Gervais, "Zool. et Pal. Franç.," 2nd ed., pl. III, figs. 1-6, pl. XXII, fig. 8.

³ Blainville, "Ostéographie," Genus *Sus*, pl. IX.

⁴ It has been elsewhere stated that the species occurs in the Narbada; the mandible on which that statement rests belongs, however, to another species.

⁵ On page 81 of the Xth volume of the 'Records' a portion of the left maxilla of a large bunodont artiodactyle was described by the present writer under the name of *Hippopotamodon sivalense*. It contains two teeth which were assumed to be $\underline{m.2}$ and $\underline{m.3}$. Subsequent examination has shown that the specimen really belongs to the present species of *Sus*, $\underline{m.3}$ being absent by an abnormality: the teeth at first regarded as $\underline{m.2}$ and $\underline{m.3}$ are really $\underline{m.1}$ and $\underline{m.2}$. The specimen is now in the Indian Museum (No. B. 7).

Mandible.—As it is to great extent on the characters of the mandible that the present species is distinguished from the last, it will be well to commence with the description of that part. It is unfortunate that there is such an element of uncertainty as to whether the mandible figured in plate XI. really belongs to *S. giganteus*, since there is no doubt of the distinctness of the mandible of the present form from that specimen. Putting, however, that specimen on one side, there are characters in the mandible, and other remains of the present form, which appear to leave but little doubt of its specific distinctness from *S. giganteus*, assuming that species to be founded on characters of the cranium alone.

In figure 4 of plate VII. there is represented the cheek-dentition of a portion of the right ramus of the mandible of a large-sized pig collected by Mr. Theobald in the Siwaliks of the Potwâr district of the Punjab. The four last teeth are still remaining, and are in beautiful preservation. In advance of $\text{pm. } \bar{4}$ there remain the fangs of $\text{pm. } \bar{3}$: the last molar is unworn, the two preceding teeth being in an intermediate condition of wear. It will, perhaps, be simplest to commence by contrasting this mandible with the one figured in plate XI. In the first place, the molar teeth of the two have a somewhat similar general structure, the pattern formed on their worn surfaces being a simple one; but the proportionate size of the three teeth is very different in the two. Thus in the present jaw the united length of the three molars exceeds that of the corresponding teeth of the other jaw; the length of $\text{m. } \bar{3}$ is, however, nearly the same in the two, though the width of that tooth is greater in the present specimen: the smaller proportionate length of $\text{m. } \bar{3}$ in the latter is caused by its smaller talon, the portion behind a being shorter than that between a and c , while the reverse is the case in the other specimen. The first and second molars ($\text{m. } \bar{1}$ and $\text{m. } \bar{2}$) of the present jaw are much longer than in the other jaw; their united length being greater, instead of less, than that of $\text{m. } \bar{3}$: the former teeth are also proportionately narrower in the present specimen, as is well seen in $\text{m. } \bar{1}$ which is an elongated tooth, with its length considerably exceeding the width of $\text{m. } \bar{2}$, as in existing pigs; whereas in the other jaw the length of this tooth is less than the width of $\text{m. } \bar{2}$. Precisely similar relations obtain between the length of $\text{m. } \bar{2}$ and the width of the last molar.¹ As far as can be judged from the slightly different stages of wear of the two specimens, it appears that the columns of $\text{m. } \bar{3}$ are relatively higher in the present specimen (*a view of the inner surface of this tooth is given in plate VII., fig. 10*). Coming to the premolars, it will be seen that $\text{pm. } \bar{4}$ is a relatively smaller tooth than in the jaw figured in plate XI., and has not the great lateral expansion at its posterior extremity so characteristic of the latter: this tooth in the jaw under consideration exhibits, however, a large column (a) on the inner side, which is not present in existing pigs. The broken base of $\text{pm. } \bar{3}$ shows

¹ It may be observed that in many species of *Sus*, especially those with taller and more complex molars, the first and second molars when very much worn become abnormally short, owing to the pressure of the adjacent teeth. As, however, the lower teeth represented in pl. XI., and the upper teeth of *S. giganteus* represented in fig. 12 of pl. LXXI. of the "F.A.S." (which have the same proportions as those in pl. XI. of this volume) are in the same stage of wear, which is only a degree beyond that of the lower teeth represented in pl. XI., no vitiation of the comparisons can occur from this source. The molars of all these specimens retain their original length.

that this tooth was inserted only by two fangs, and was, therefore, quite unlike the corresponding tooth of the mandible figured in plate XI. The vertical height of the present specimen, as well as its width, is considerably less than that of the latter. The sex of the specimen under consideration cannot be certainly determined, but from the characters of a specimen described below it not improbably belongs to a female.

In figure 1 of plate VIII. there is represented a fragment of the right ramus of a similar mandible, collected by Mr. Theobald in the Punjab, containing $\overline{pm. 4}$, $\overline{m. 1}$, and $\overline{m. 2}$, in a somewhat less worn condition than in the last specimen. The section of the root of the canine in this specimen indicates that it belonged to a male individual, like the jaw figured in plate XI.: the true molars are precisely the same as in the specimen represented in plate VII., fig. 4, but $\overline{pm. 4}$ is rather wider: the roots of $\overline{pm. 3}$ are not exhibited.

There is a third specimen in the Indian Museum (No. B. 358) precisely similar to the one represented in plate VII.; and a fourth in the Museum of the Royal College of Surgeons (No. 1805); both of which specimens were collected from the Siwaliks of the Punjab by Mr. Theobald.

From the foregoing comparisons (as well as from the dimensions given below) there seems no doubt of the specific distinction of the specimens under consideration from the mandible figured in plate XI., irrespective of the question to what species that specimen belongs.

With regard to the crania of *S. giganteus*, it is tolerably clear from the considerations advanced under the head of that species that the lower molars were probably of the proportions of those of the mandible represented in plate XI., and, therefore, that the mandibles under consideration do not belong to that species. The first and second molars of these mandibles are of the elongated type of those of *S. erymanthus* and *S. major*; and it may, therefore, be inferred that the corresponding upper molars were likewise of the type of those of the two last-named species, which have already been shown to be narrower than those of *S. giganteus*.¹ Since $\overline{m. 2}$ of the present mandibles is about half as long again as $m. 2$ of *S. giganteus*, the former specimens indicate an animal of considerably larger size than the latter.

From these considerations it may be taken that the present form of mandible most probably indicates a second species of large Siwalik *Sus*, with molars of a simple structure. The talon of the last tooth of the specimen represented in plate VII., fig. 4, consists of a single median column (*a*), behind which there is a semicircular portion comprising a large outer (*b*), and a smaller and lower inner column (*c*). In the talon of the corresponding tooth of *S. cristatus* and *S. scrofa* there is another column behind *b* and *c*; and even in the simpler tooth of *S. andamanensis*² the talon is of a more complex structure.

The figures in the first column of the following table give the dimensions of the mandible represented in plate VII., fig. 4; those in the second of the one in

¹ Compare Prof. Gaudry's figures (*op. cit.* with plate XI, fig. 2, and with pl. LXXI, fig. 12, of the "I. A. S.")

² Vide Rolleston, *op. cit.*, pl. XLIII., fig. 8.

plate VIII., fig. 1; and those in the third the corresponding dimensions of *S. cristatus*:—

	Present species.	<i>S. cristatus</i> .
Height of ramus at m. 2	3.0	2.0
Thickness of ditto	2.0	1.2
Length of three true molars	4.45	3.1
" " " "	1.0	0.6
Width " " "	0.76	0.4
Length " m. 1	0.97	0.65
Width " " "	0.74	0.59
Length " " 2	1.42	0.88
Width " " "	1.0	0.6
Length " " 3	2.16	1.65
Width " " "	1.2	0.7

It seems from a broken fragment of a mandible of a male from the Punjab in the Indian Museum (No. B. 8), with the crowns of the teeth hammered off, that *p.m.* 3, though a small and narrow tooth when compared with that of the mandible figured in plate XI., apparently had the hinder root divided into two. This seems to indicate that the jaw represented in plate VII., fig. 4, is probably that of a female. The vertical diameter of the canine in the male jaw is 1.22 inches.

Cranium. — In plate IX. there is figured ($\frac{1}{2}$) the skull of a gigantic pig obtained by Mr. Theobald from the Siwaliks of the village of Niki, in the Punjab, which has been previously alluded to by the present writer under the name of *S. giganteus*.¹ This specimen is in such frail condition that its transport to England was deemed inadvisable, and the writer has consequently been unable to compare it with the crania of *S. giganteus*, and cannot give such full measurements as he would desire. The mandible is *in situ*; and the chief damage that the specimen has sustained consists in the loss of the angle of the mandible, the occipital condyles, a portion of the exoccipitals, and the tip of the nasals. The whole of the teeth are in beautiful preservation; but from the apposition of the upper and lower series they cannot be fully examined.

The mandible and lower molars agree exactly in general characters with the specimen represented in plate VII., fig. 4; and the skull may, therefore, be safely referred to the same species. The present specimen shows that $\overline{\text{pm.1}}$ was present, and was separated by a considerable interval from $\overline{\text{pm.2}}$, as in existing pigs. The mandibular symphysis is relatively short, with a rapidly ascending inferior border. The canines are of fairly large size, and indicate that the specimen probably belonged to a male. The upper molars have the same length as the lower; and the length of $\overline{\text{m.1}}$ and $\overline{\text{m.2}}$ apparently exceeds that of $\overline{\text{m.3}}$: $\overline{\text{pm.1}}$ is present.

Although the naso-frontal suture is not visible, yet it can be easily seen that the nasals when complete must have been shorter than the fronto-parietal portion of the cranium; thus showing that the species was in this respect allied to *S. giganteus* and the *S. cristatus* group, and quite different from *S. scrofa* and *S. barbatus*. The protuberance above the upper canine is of about the same proportionate size as in *S. cristatus*. Comparing the figure with that of the cranium of *S. giganteus*,² it

1 'Records,' vol X , pp 81-2

² "F.A.S.," plate LXIX., fig. 16. The two figures are not drawn in the same position.

appears that the proportionate height at the orbit is somewhat less; the orbit smaller, and placed less below the frontal profile; and the interval between the zygoma and the molar alveoli much smaller. The anterior border of the orbit extends still farther over m. 3 in the present specimen than in *S. giganteus*. Although the occipital regions of both specimens are more or less damaged, and comparison is, therefore, difficult, it seems that the condylar region was decidedly more prominent in the present specimen. It is also not improbable that the pre-orbital concavity of the latter was smaller and shallower, although this cannot be certainly determined. The general form of the two crania is, however, very similar. The palate of the present specimen is unfortunately invisible. The dimensions of the Niki skull are as follows, *viz.*:—

Length from supra-occipital to incisors	23 0
Interval between ditto and angle of mandible	8 0
Width above orbits	5.4
Length of series of upper cheek-teeth	7 3
" " exposed portion of lower canine	2 5
" " " " " " incisors	1 4
Long diameter of upper canine	1.25
Depth of mandible at <u>m. 3</u>	3 3
Width of mandibular symphysis	2 6
Length of three true lower molars	4.4 (r)
" " <u>m. 1</u>	1.08
Interval between <u>pm 1</u> and <u>pm 2</u>	1 1

Detached molars.—In plate VII., fig. 6, there is represented the unworn crown of a third right upper true molar of a large pig, collected by Mr. Theobald in the Siwaliks of Asnot, Punjab, which from its large size and comparatively simple structure may probably be referred to the same species as the specimens described above. The length of this tooth is 2.43 and its greatest width 1.7 inches; and, judging from the length of m. 3, it indicates an individual somewhat larger than the one to which the mandible represented in plate VII., fig. 4, belonged. The four main columns of the crown are bold and distinct, and separated by very wide open valleys: the accessory columns (*a*, *g*, *h*) are also large, and are restricted to the median line. The talon is very short, its whole length being less than the interval between *a* and *g*: it consists of a central accessory lobe (*a*), and of a short semi-circular portion (*b*) immediately behind the latter. A very distinct cingulum, raised into a number of cusps, surrounds the anterior and inner sides of the crown, and coalesces posteriorly with the talon. The extreme shortness of the talon of this tooth is in harmony with the corresponding part of m. 3, and indicates that the united length of m. 1 and m. 2 exceeded the length of the present tooth.

Compared with m. 3 of *S. giganteus*¹ this specimen is distinguished by its vastly superior size; its shorter and wider talon, the portion *b*, *c* being more developed laterally; the wider and more open valleys, with the restriction of the accessory columns to the median line; and lastly by the presence of the conspicuous cingulum,

¹ Plate XI, fig. 2, and 'F.A.S.', pl. LXXI., fig. 12.

of which there is no trace in the little-worn tooth of *S. giganteus* figured in the "F.A.S."

In plate VII., fig. 3, there is represented a slightly worn and partially broken last right lower true molar, collected by Mr. Theobald in the Potwâr district, which agrees so closely with $\overline{m.3}$ of the specimen represented in fig. 4 of the same plate, that there seems every reason for referring it to the same species. This tooth has a length of 2.65, and a maximum width of 1.5 inches; and it apparently indicates an animal still larger than that to which the specimen last described belonged: its size is indeed scarcely inferior to that of the corresponding tooth of *Hippopotamus amphibius*. This tooth differs from $m.3$ of the mandible represented in fig. 4 of the same plate merely by the outer portion (*b*) of the talon extending somewhat behind the inner portion (*c*); thus causing the whole talon to be somewhat longer.

Limb-bones.—In figures 1 and 2 of plate XII. of this volume there are figured the distal half of the left radius (fig. 1), and the third and fourth left metacarpals (fig. 2) which were obtained, in company with some broken bones, by Mr. Theobald from the Siwaliks of the village of Niki in association with the cranium figured in plate IX. From the circumstance that the fracture of the radius is quite recent, and that the articular surfaces of the metacarpals and radius are perfectly uninjured, with their ridges sharp and distinct, there is no doubt that the whole skeleton was originally in juxta-position, and was broken up in the process of extraction. In the following table the dimensions of the figured bones are compared with those of the corresponding bones of a skeleton of a male of *S. scrofa* in the Museum of the Royal College of Surgeons (No. 1765); *viz.*,

	Fossil.	Recent.
Length of third metacarpal	4.5	3.46
Transverse diameter of ditto distally	1.19	0.86
" " " distal end of radius	2.5	1.6

The fossil bones agree so closely in general form with those of the existing species, that they do not afford any characters of specific value. The skeleton of *S. scrofa* has a height of 31 inches at the shoulder; and taking the length of the third metacarpal as a modulus, the calculated height of the skeleton of the fossil would be 40 inches, or ten 'hands';—the height of a good-sized pony. The molars of the skull of the Niki pig (pl IX.) are, however, by no means the largest which may probably be referred to that species, being about the size of those of the mandible represented in plate VII., fig. 4, in which the length of $m.1$ is 2.16 inches. The larger corresponding tooth represented in fig. 3 of the same plate has a length of 2.65 inches, and the calculated height of the skeleton of the individual to which that specimen belonged would be upwards of 49 inches, or $12\frac{1}{4}$ 'hands';—the height of a small horse.

Specific distinctness and affinities.—As the result of the foregoing comparisons it appears that there is a very strong probability that the specimens described above are specifically distinct from *S. giganteus*—a probability which will be almost a certainty if the mandible figured in plate XI. be correctly referred to that species.

The species to which the present specimens belong is certainly distinct from all existing forms of the genus; and the only fossil species mentioned in the list on pages 51-2 with which it can compare in size, and the structure of the molars, are *S. antiquus*, *S. erymanthius*, *S. major*, *S. provincialis*, and *S. cherotherium*. The first is apparently mainly known by two specimens of the mandible figured by Kaup.¹ In one of these² the canine is relatively small, and the specimen is consequently referred by Kaup to a female: in the other,³ which is regarded by Kaup as a male, the middle incisors are present: then there is an empty alveolus on each side, behind which there is a slender upwardly-directed tooth which Kaup regards as i 3, the canines of both sides being, on Kaup's view, absent through malformation. In the present writer's opinion it is far more probable that these up-curving teeth are really the canines (the second and third incisors having belonged to the empty alveoli), and that the jaw really belonged to a female; the specimen referred by Kaup to a female belonging to a male. If this view be correct, *S. antiquus* will be distinguished from the present species by its very small canines. It is also distinguished by the more horizontal direction of the lower incisors; while its pm. 4 is not wider than m. 1, and the inner column (*a*) of the former, although present, is not so strongly developed. The two species agree in the proportionate size of the true molars, and in having the united length of m. 1 and m. 2 greater than that of m. 3. In *S. erymanthius* and *S. major*, which, as already said, are regarded by Prof. Gaudry as being probably races of the same species, the form of the cranium is very different from that of the specimen represented in plate IX.: the European species are also distinguished by their small canines, by the small size, or absence, of the protuberance over the upper canine, and by the general absence of pm. 1 in both jaws. The cheek-teeth of the European species present a striking resemblance to those of the present species; the lower molars having the same simple structure, and the length of m. 1 and m. 2 exceeding that of m. 3 (this character being most marked in *S. major*): pm. 4 is, however, relatively narrower, and has but an indistinct trace of the accessory inner column (*a*); pm. 3 is a very narrow tooth, and shows no indications of having had three roots, which appears to have been the case in at least some male individuals of the present species. The last upper molar has no trace of the conspicuous cingulum of the tooth represented in plate VII., fig. 6; and in the European molars the valleys seem slightly less open, and the accessory columns less strictly confined to the median line. Both the figured specimens of the dentition of the European species are smaller than that represented in plate VII., fig. 4; and no individuals are known to have attained anything like the size of those to which the teeth represented in figs. 3 and 6 of the same plate belonged. The molars of *S. provincialis* present a certain resemblance to those of the present form, but are of considerably smaller size: the talon of m. 3 is, however, much narrower, and that tooth has not the cingulum on the inner side which is so conspicuously developed in the tooth figured in plate VII., fig. 6: the last

¹ "Beitrage," pt. IV., pls IV-V.

² *Ibid.*, pt. IV., figs 1, 1c

³ *Ibid.*, pt. IV., fig 2, pl V

⁴ Gervais, "Zool. et Pal. Franç.," pl III, figs 1-6, pl XXII, fig. 8.

lower premolar is apparently proportionately narrower. The molars of *S. cherotherium*,¹ besides their inferior size, are readily distinguished by the extremely simple structure of the columns on their crowns.

From the foregoing evidence it appears that there is every probability of the present species being distinct from every described form; and it is therefore allowable to assign to it at least a provisionally distinct name: from the very large size of the species the name *S. titan* may be appropriately applied. This species in the structure of its true molars was evidently allied to the above-named fossil species from Eppelsheim, Pikermi, and Mont Lebéron; but was much more specialized in the development of its canines than the species from the two latter localities, and apparently also, although to a less extent, than the Eppelsheim species. This large development of the canines is a well-marked instance of the specialization, and consequently late geological age, of the Siwalik fauna. In the structure of its lower premolars *S. titan* is intermediate between the mandible referred to *S. giganteus* and the fossil European pigs; pm. 4 being a wider tooth than in the latter, and pm. 3 in some instances retaining evidences of the relationship of its owner to a *Tetraconodon*-like form by the retention of three distinct roots. Although it is probable that *S. titan* and the large European fossil pigs are nearly connected, it is at present impossible to indicate the home of the common ancestral stock.

Distribution.—All the specimens described above were obtained from the Siwaliks of the Punjab.

Species 3: *SUS FALCONERI*, n. sp., *nobis*.

Syn. *Sus giganteus*, F. and C., *in parte*.

Sus sivalensis, Blain. (*non* Falc. and Caut.)

Sus, sp. nov., Baker and Durand.

History.—The name of the present species is mentioned here for the first time; the specimens on which it is founded having been previously either referred by Falconer and Cautley to *S. giganteus*, by De Blainville to *S. sivalensis*, or not specifically named.

Cranium of male.—In figures 3, 3a, 3b of plate LXIX. of the "F.A.S." there are given three small-sized views of the cranium of a Siwalik pig in the collection of the British Museum (No. 16,386), under the name of *S. giganteus*. The specimen has lost the extremity of the muzzle, but is otherwise nearly complete anteriorly: posteriorly it is broken off in the middle of the temporal fossa, and has lost a portion of the fronto-parietal region: the teeth are all well worn, and indicate an aged animal.

In describing this specimen it will be simplest to indicate in what respects it differs from the crania of *Sus giganteus* and *S. titan*, which have been shown to be of the same general type, and may therefore be considered together. In the first place, the size of the check-teeth indicates an animal nearly or quite as large as the British

¹ Blainville, "Ostographie," Genus *Sus*, pl. IX

Museum type skull of the first of those species; but the proportions of the two skulls are very different. Thus while in *S. giganteus* the vortical height of the cranium at the infra-orbital foramen is 5·4, and at pm. 4 4·3 inches, in the present specimen these dimensions are only 4·3 and 2·9 inches: the width across the parietals between the temporal fossæ in the present specimen is, moreover, nearly twice that of *S. giganteus*. The protuberance above the canine in the present specimen is also extremely large and elongated, whereas it is comparatively small and short in the cranium of *S. titan* (pl. IX.), which is probably that of a male: the large size of this protuberance and of the alveolus of the canines indicates that the present specimen likewise belongs to the male sex. The present specimen also differs from the cranium of *S. giganteus* by the narrower and less prominent zygomatic arches, as well as by the more anterior direction of the axis of the orbit.

The present cranium is indeed of a longer and lower form than that of *S. cristatus*, and comes nearest in this respect to the cranium of the existing *S. barbatus*¹ of Borneo; in which the facial portion is very long and low, with a marked rise above the orbit towards the occiput. The fossil and recent crania also agree in possessing a long protuberance above the canine, extending backwards as far as m. 1, instead of stopping at pm. 2 as in other living pigs, *S. titan*, and probably *S. giganteus*; and in having the extremity of the muzzle much elongated and deflected considerably below the plane of the grinding surface of the cheek-teeth; this character being, however, most marked in the fossil. The two crania also resemble one another in the form of the pre-orbital concavity, and in having the anterior border of the orbit placed considerably behind m. 3; although this character also is most strongly developed in the fossil. In all these respects the latter differs very widely from *S. giganteus*; in which the infra-orbital sulci are shallower and less curved; their form being unknown in *S. titan*. Other comparisons will be made in the description of the next specimen; but it may be mentioned here that the skull of *S. barbatus* is readily distinguished from the present specimen by the much greater production of the palate behind m. 3. In the following table the teeth of the present specimen are compared with those of *S. cristatus*, viz.:—

	Specimen.	<i>S. cristatus</i> .
Length of three true molars	3·55	2·9
„ „ pm. 4	0·51	0·52
Width „ „ „	0·65	0·55
Length „ m. 1	0·68	0·62
„ „ „ 2	0·94	0·84
Width „ „ „	0·9	0·7
Length „ „ 3	1·94	1·51
Width „ „ „	1·14	0·82
Long diameter of canine	1·1	1·0

In the present specimen the length of m. 3 considerably exceeds the united length of the two preceding teeth: but this appears to be in great part due to the much worn condition of the latter, as it is not the case with little worn specimens

¹ The skull of this species is figured by Rolleston, 'Trans. Linn. Soc.,' Zool., ser. 2, vol. I., pl. XLIII., fig. 7.

described below. The structure of the molars of the present specimen is much more complex than in *S. giganteus* or *S. titan*; but these characters are better exhibited by less worn specimens described in the sequel. The last upper molar of *S. barbatus* is much simpler than that of *S. cristatus*, and is, therefore, quite unlike the corresponding tooth of the fossil.

Cranium of female.—In plate X. of the present volume there is represented ($\frac{1}{2}$) the skull of a female pig from the Siwaliks, which from its general agreement with the last specimen may be referred to the same species: the right upper check-dentition of this cranium is represented of the full size in plate VII., fig. 7. This specimen is preserved in the Science and Art Museum, Dublin (No. C. 27), and is one of those figured and described by Baker and Durand.¹ It is nearly complete and has suffered but slightly from crush: all the teeth, with the exception of the canines and outer incisors, are in position; all the true molars are very much worn; and the alveoli of the canines and outer incisors are filled with matrix. In general form this skull agrees very closely with the male specimen; being distinguished only by the small size of the canines, and the absence of the overhanging protuberance. These two characters clearly indicate the female sex of the present specimen.

The more perfect preservation of the present specimen permits of fuller comparisons than were possible with the male skull. Thus it is seen that the length of the nasals² considerably exceeds the length of the fronto-parietal region; and it is, therefore, evident that the present species has no affinity with *S. titan*, *S. giganteus*, and the *S. cristatus* group, in which the reverse is the case. The present specimen also shows the wide and flattened fronto-parietal region, the narrow nasals, and the deflected muzzle; as well as the advanced position of m.³ in regard to the orbit; in all of which characters it differs from *S. giganteus* and *S. titan*.³ The extension of the palate behind the last-named tooth is intermediate between the condition prevailing in *S. giganteus* and *S. cristatus*. The zygomatic arches are wider in the middle than posteriorly; which is a character given by Rolleston⁴ as distinctive of *S. barbatus*: the pre-orbital concavity is also deep as in that species, instead of wide and shallow as in *S. scrofa*.

As it is apparently only in *S. scrofa* and *S. barbatus* among living pigs that the length of the nasals largely exceeds the length of the fronto-parietal portion of the skull,⁵ it is evidently only with those two that the fossil is allied. It is distinguished from the former by the greater deflection of the muzzle, the flattened frontals, the form of the pre-orbital concavity and of the zygomata, and the large protuberance over the canine of the male. It agrees, however, with that species in the fact that

¹ Two views ($\frac{1}{2}$ nat size) are given on plate XXXV of Baker and Durand's memoir, while the dentition of the left side is represented of the full size on plate XLIV, fig. 3, of the same memoir. The latter figure is reproduced on a smaller scale by De Blainville ("Osteographie," Genus *Sua*, pl. 1A) under the name of *S. sualensis*.

² The length of these bones can be estimated from that of the premaxillæ.

³ The width of the parietals at the temporal fossa has not been determined in this species

⁴ *Op. cit.*, p. 265.

⁵ Vide Rolleston, *op. cit.*

the summit of the occipital crest forms the highest point of the skull¹; and thereby differs from *S. barbatus*, in which "the highest point is some way in front of the occipital squama, and occupies a level far above the plane occupied by the anterior half of the frontal."²

In the following table the dimensions of the specimen under consideration are compared with those of the type skull of *S. giganteus*, with one of *S. barbatus*, of which the dimensions are given by Rolleston, and with one of *S. cristatus*:—

	<i>S. giganteus.</i>	Specimen.	<i>S. barbatus.</i>	<i>S. cristatus.</i>
Extremo length		15.8	19.7	14.6
Base line		13.5	16.7	1.2
Extreme zygomatic width	8.5	6.62	6.8	6.2
Length of nasals		8.0	10.5	6.6
" „ fronto-parietals		7.2	9.0	7.2
Width of nasals		1.5	1.5	1.7
" „ post-orbital processes	5.1	4.3	4.5	4.25
Height of occiput	6.55	4.02		5.1
Long diameter of condyle	1.6	1.13		1.2
Interval between foramen magnum and palate	3.8	4.1		3.25
Height at infra-orbital foramen	5.4	4.4		3.9
Width of palate posteriorly	1.7	1.2	1.1	1.3
" „ „ anteriorly	1.5	1.34		1.35
Greatest diameter of orbit	1.35	1.75		1.6
Length of palate		9.2		8.6

In the next table the dimensions of the teeth of the present and the last specimen are compared with those of the two British Museum crania of *S. giganteus*, viz.:—

	Present species.		<i>S. giganteus.</i>	
	male.	female.		
Length of three true molars	3.65	3.48	3.2	3.7
" „ four last cheek-teeth	4.28	3.71	3.8	4.22
" „ series of „ „	5.5	5.1		
Diameter of canine	1.1	0.58		
Length of pm. 4	0.54	0.45	0.7	0.7
Width „ „ „	0.65	0.55	0.9	0.82
Length „ m. 1	0.68	0.52	0.62	0.75
Width „ „ „		0.68	0.82	0.92
Length „ „ 2	0.54	0.87	0.91	1.16
Width „ „ „	0.9	0.85	1.08	1.08
Length „ „ 3	1.61	2.1	1.7	1.85
Width „ „ „	1.14	1.0	1.2	1.22

In regard to the cheek-dentition it will be observed that, as in the male cranium, the length of m. 3 considerably exceeds the united length of the two preceding teeth, but this character is largely due to mutual pressure, and the worn condition of the teeth; m. 1 and m. 2 having lost their enamel on both their anterior and posterior borders. The third premolar is of the normal shape, and therefore quite distinct from the corresponding tooth of *S. giganteus* (plate XI., fig. 2): the first premolar is remarkably small, but is rather larger in the male cranium. The last true molar (plate VII., fig. 7) exhibits an extremely complex structure on its worn surface, the talon being much produced, and the portion behind a relatively more developed than in the corresponding teeth of *S. giganteus* (plate XI., fig. 2) and *S. tilan* (plate VII., fig. 6):

¹ Vide Rolleston, *op. cit.*, pl. XLII., fig. 5.

² *Ibid*, p. 265, pl. XLIII., fig. 7.

the whole talon indeed exceeding the length of the hinder main columns. The complexity of the pattern on the worn surface is produced by the number and large size of the accessory columns (which completely block the lateral valleys) and by the vertical grooving of the enamel; the latter character causing the section of the enamel in certain stages of wear to present a folded, or crenulated, appearance. This structure is present to a certain extent in the molars of most pigs, but is never so strongly developed as in the present form. In the elongated m. 3, and the complex pattern on its crown, the cranium is widely different from *S. barbatus*.

Other specimens.—In the memoir cited Baker and Durand described an imperfect cranium of a male of which they figured the left dentition¹: that specimen seems to agree in all respects with those described above, and belonged to an old individual, the first and second molars being completely worn down, and their united length much less than that of m. 3: the latter tooth is rather larger in all its dimensions than that of the female skull, but exhibits the same complexity of structure. The subsequent history of this specimen is unknown. In the Science and Art Museum, Dublin, there is the middle portion of a crushed skull (No. C. 31), of which the dentition of the left side is represented in plate XLIV., fig. 4, of Baker and Durand's memoir. This specimen appears to agree exactly with the typical male skull, although the crush to which it has been subjected makes it appear relatively higher: the teeth are well worn. The dimensions of its check-teeth are as follows, *viz.*:—

Length of three true molars	3·6	Length of <u>m. 3</u>	2·0
„ „ <u>m. 2</u>	1·0	Width „ „ „	1·1
Width „ „ „	0·9		

In the British Museum there is the palate of a younger individual in which m. 3 has not come into wear: the left dentition of this specimen is represented in plate XLIV., fig. 2, of Baker and Durand's memoir. From its little-worn condition, and consequent absence of pressure by m. 3, the second true molar is much longer in this specimen than in any of those previously described; the united length of this and the preceding tooth equalling that of m. 3: m. 2 very clearly exhibits the characteristic complex pattern of the masticating surface. The dimensions of the teeth of this specimen are as follows, *viz.*:—

Length of <u>pm. 4</u>	0·49	Length of <u>m. 2</u>	1·29
Width „ „ „	0·6	Width „ „ „	0·84
Length „ <u>m. 1</u>	0·74	Length „ „ <u>3</u>	2·03
Width „ „ „	0·66	Width „ „ „	0·97

The palate of a still younger individual in the British Museum (represented in “F.A.S.” pl. LXXI., fig. 14, and in pl. XLIV., fig. 1, of Baker and Durand's memoir²), in which m. 3 is still *in alveolo*, exhibits precisely similar characters, but the dimensions of m. 2 are only 1·2 and 0·83. The greater portion of a young skull in the same collection, represented in plate LXX., figs. 4, 4a, 4b, of the “F.A.S.,”

¹ Plate XLIV., fig. 5.

² This figure is reproduced on a reduced scale by De Blainville (“Ostéographie,” Genus *Sus*, pl. IX.), under the name of *S. sivalensis*.

agrees in contour with the type skulls, and shows the elongated m. 2 characteristic of young individuals.

In figure 5 of plate VII. of the present volume there are represented the cheek-teeth of one side of the hinder part of a palate of a Siwalik pig in the British Museum¹; in which there is seen a fragment of the well-worn m. 1, and the complete m. 2 and m. 3: the last is untouched by wear, while m. 2 is in a middle stage of detrition. The dimensions of this specimen are as follows, *viz.*:—

Length of <u>m. 2</u>	1.4	Length of <u>m. 3</u>	2.2
Width „ „ „	0.83	Width „ „ „	1.1

In this specimen m. 2 exhibits very perfectly the extreme complexity of pattern characteristic of the present species, and is more elongated than in any other jaw. The last molar is also unusually complex; its length being greater in proportion to its breadth than is normally the case with the corresponding tooth of any described species of the genus. Although the molars of this specimen are slightly longer than those of any of the specimens yet described, the jaw may be safely referred to the same species. In figure 8 of the same plate there is represented a fragment of the right maxilla of a pig in the Siwalik collection of the Indian Museum, containing m. 2 and m. 3, which present similar characters to the foregoing, although of somewhat smaller dimensions²: both teeth are more worn than in the specimen last described, and m. 2 is imperfect anteriorly. Their dimensions are as follows, *viz.*:—

Length of <u>m. 2</u>	0.92 (†)	Length of <u>m. 3</u>	1.7
Width „ „ „	0.79	Width „ „ „	0.91

From their little worn and perfect condition the teeth of these two specimens exhibit in the most marked degree the points distinguishing the molars of the present species from those of *S. giganteus* and *S. titan*. Thus, if the perfect m. 2 in figure 5 be compared with the slightly more worn homologous tooth of the former in the jaw represented in fig. 12 of plate LXXI. of the “F.A.S.,” and with the more worn one in plate XI., fig. 2, of this volume, the contrast between the elongated crown, with the complex pattern on its worn surface, of the one, and the square crown, with its simple pattern, of the other, will be at once perceived. The corresponding upper tooth of *S. titan*, although probably more elongated than that of *S. giganteus*, must have been much wider than the corresponding tooth in fig. 5, since the dimensions of the latter are almost the same as those of the lower tooth of *S. titan* represented in fig. 4, and upper molars are always much wider than their corresponding lower teeth. Similarly if the last molars of the two specimens under consideration be compared with the corresponding tooth of *S. giganteus*, and that of *S. titan* represented in fig. 6 of the same plate, analogous differences will be observed. Thus the hindmost teeth of the present species are much longer and narrower; and their talon, instead of consisting simply of one median column (*a*) with a horseshoe-shaped portion (*b*) behind it, consists of the same median column (*a*) with a pair of columns (*b*) behind,

¹ This specimen is also figured in pl. LXXI., fig. 13, of the “F.A.S.,” under the name of *S. giganteus*.

² This specimen is the one mentioned under the number 318 in the note on page 513 of the first volume of the “Paleontological Memoirs”; where it is referred simply to *Sus*.

beyond which again there is a mass of agglomerated columns (*c*). The last tooth of the present specimens is further distinguished by the inner surfaces of the main inner columns being flatter, and by the valleys between the main columns being almost entirely blocked by the development of a number of small columns on either side of the median accessory columns (*f. g.*). The tooth of *S. tilan* is still more markedly different in these respects than that of *S. giganteus*. Compared with *m. 3* of *S. cristatus*, which according to Rolleston is more complex than in any existing species of the genus, the corresponding tooth of the present specimens differs by the greater complexity of the portion *b* and *c*, causing the whole tooth to be relatively longer; and by the columns on the median line (*a, f, g*) being more distinct from the four main columns; as well as by the greater development of accessory columns in the terminations of the transverse valleys. The simple molars of *S. barbatus* present no resemblance to the present specimens.

In the Dublin Museum there is a detached right *m. 3* of a Siwalik pig (No. C. 30), agreeing in all essential characters with the corresponding tooth of the female skull represented in plate X., although of smaller size; its dimensions being 1.73x0.94.

Mandible of male.—In plate LXX., fig. 5, of the "F.A.S." there is represented the mandible of a large Siwalik pig, which from the great size of the canines evidently belonged to a male. This specimen is in the British Museum, and exhibits all the cheek-teeth in a well-worn condition: the inferior aspect of the symphyseal portion is still obscured by matrix and the incisors are incomplete. From the circumstance that the last molar of this specimen is of a very elongated form (exceeding the length of the two preceding teeth) and exhibits an extremely complex pattern on the worn masticating surface, it may be inferred that it belongs to the present species. The symphysis extends backwards as far as *pm. 3*, and there is a longer interval between *pm. 2* and the canine than in the mandible of *S. tilan* figured in plate IX.; the canine is also relatively larger than in that specimen. The premolars are not well preserved, but they show that *pm. 3* was of the same form as in existing pigs. A comparison of the figures will at once show that this specimen is specifically distinct from the mandible of *S. tilan* (plate VII., fig. 4) and from that provisionally referred to *S. giganteus* (plate XI., fig. 1).

A very similar specimen is represented in plate XXXV., fig. 4, of Baker and Durand's memoir. The dimensions of these specimens will be given after the description of the mandible of the female.

Mandible of female.—In plate LXIX., fig. 4, of the "F.A.S." there is given a reduced lateral view of the left ramus of a nearly complete mandible of a Siwalik pig now in the Dublin Museum of Science and Art, being one of the specimens collected by Baker and Durand. The right dentition of this specimen is figured of the full size in plate VII., fig. 1, of the present volume. The specimen shows all the teeth, which are in a well-worn condition; but the crowns of *i. 3*, the canine, *pm. 1*, and *pm. 2* have been broken off: the small size of the canine indicates that the

jaw belonged to a female. In the following table the dimensions of this specimen and of the two mandibles of males are compared with those of the mandible of a male of *S. cristatus*; viz.:—

	Specimens.		<i>S. cristatus.</i>
	Male. ¹	Female.	
Length of three true molars	3·8	3·5	3·1
„ „ five last cheek-teeth	5·0	4·7	4·08
Width of symphysis between external borders of alveoli of canines	3·4	2·42	2·7
Interval between canine and pm. 2	1·9	1·2	1·26
Length of symphysis	3·9	3·47	3·1
Height to summit of m. 3		2·66	2·67
„ „ alveolus of i. 2		1·18	1·6
Length of m. 1		0·5	0·65
Width „ „ „		0·57	0·69
Length „ 2	1·08	1·05	0·88
Width „ „ „	0·72	0·69	0·6
Length „ 3	2·04	1·94	1·65
Width „ „ „	0·86	0·76	0·7
Long diameter of canine	1·2	0·6	0·93
Intermolar space at m. 3	1·6	1·12	1·4

The complex pattern on its worn surface, and the elongated shape of m. 3 of the female jaw, clearly indicate that this specimen should be referred to the present form. It will be seen from the measurements that the superior surface of the extremity of the symphysis is much lower in the present specimen relatively to the detrital plane of the cheek-teeth than in the jaw of *S. cristatus*; the inferior border of the symphysis also forms a much less marked angle with the inferior border of the horizontal ramus, although this feature is somewhat exaggerated in the figure in the “F.A.S.” These features are evidently in correlation with the deflection of the premaxillary region of the cranium of the present species. The cheek-teeth of the female jaw are relatively rather longer than in that of the male, and the intermolar space is somewhat less; both these characters corresponding with those prevailing in the crania. It will be seen that pm. 3 and pm. 4 are narrow teeth like those of existing pigs; the latter wanting the distinct inner column which occurs in the corresponding tooth of *S. titan* (*a*, fig. 4), and being widely different from the same tooth in the jaw referred to *S. giganteus* (plate XL, fig. 1): pm. 3 is inserted by two roots only, and is therefore quite different from the same tooth in the latter jaw. The characters of the true molars will be best gathered from the specimens described below.

Lower molars.—In plate VII., fig. 2, of the present volume there is represented from the masticating aspect a fragment of the right ramus of the mandible of a pig formerly in the collection of the Asiatic Society of Bengal, which was obtained by the late Sergeant Dawe from the Siwaliks of the neighbourhood of Nahan. It is described by Falconer² in the following words:—“*Sus*; Fragment of lower jaw, right side, comprising posterior part of horizontal ramus, broken across horizontally near the base of the teeth, and containing the last two molars, the penultimate well worn, with very flexuous enamel; the last molar in germ and of very large size.”

¹ The specimen in the first column is the British Museum, and that in the second Baker and DuRand's specimen.

² *Vide* “Pal. Mem.,” vol. I., p. 513, note (No. 319).

Since Falconer's notice the anterior wall of $\overline{m.2}$ has been broken away. The inner aspect of $\overline{m.3}$ is represented in fig. 9 of the same plate. A larger fragment of the corresponding ramus of another mandible, from the Siwalik Hills, containing the three true molars, is represented in plate LXXI., fig. 15, of the "F.A.S." under the name of *S. giganteus*, and is preserved in the British Museum (No. 16,612). In that specimen the cheek-teeth are in nearly the same condition of wear as the mandible represented in plate VII., fig. 1, of the present volume, and the length of $\overline{m.3}$ exceeds that of the two preceding teeth. Since the molars of all three specimens agree exactly in the complex pattern formed on their masticating surfaces, in their elongated shape, and in the long talon of the last tooth; while the teeth of the British Museum specimen agree almost exactly in size with those of fig. 1, those of fig. 2 being somewhat larger, the whole of the three specimens evidently belong to the same, or a closely allied, species.

Comparing the molars of the specimen represented in fig. 2 with those of *S. titan* represented in fig. 4 of the same plate (the degree of wear of the latter being very slightly less than that of the former), it will be seen that the pattern of the worn surface of $\overline{m.2}$ is much more complex in the present specimen; the transverse valley on the outer side being entirely obliterated by the detrition of the outlying columns situated therein: the whole crown is moreover relatively longer and narrower. In $\overline{m.3}$ the distinctive characters of the two forms are, if possible, still more distinctly displayed. Thus the talon of that tooth in the present specimen has the median column (*a*) corresponding to that of *S. titan*; in the portion *b* and *c* the inner column is, however, more developed, being as large as the outer column; while behind these there is the portion *d* which is entirely wanting in *S. titan*. The main columns in the present species are flattened on their lateral surfaces; and the lateral accessory columns are so developed as to almost completely block the outer terminations of the transverse valleys; this being especially noticeable in the first valley. On the inner lateral surface (figs. 9, 10) it will be seen that the columns of the present species are relatively taller and wider, with their summits inclining forwards in place of being nearly vertical, and with much narrower spaces between them: the talon (*the portion to the right of ta*) is equal in length to the whole length of the rest of the crown, instead of only to half, and its first column is as high as the column immediately anterior to it: finally the whole crown is relatively higher. In the following table the dimensions of the specimen represented in fig. 2 are compared with those of the British Museum specimen, and with those of the corresponding teeth of *S. titan*, viz.:—

	Present species		<i>S. titan.</i>
	Ind Mus.	Brit Mus.	
Length of $\overline{m.2}$		0.95	1.42
Width „ „ „	0.71	0.7	1.0
Length „ „ $\overline{m.3}$	2.4	1.8	2.16
Width „ „ „	0.85	0.7	1.2
Height of first inner column of talon of ditto	1.05		0.7

These dimensions and comparisons, coupled with the totally different form of

the last premolar of the female jaw already described from that of *S. titan*, leave no doubt of the specific distinctness of the specimens under consideration from that species.

Compared with the jaw provisionally referred to *S. giganteus* (plate XI., fig. 1), still more striking differences obtain, since the crowns of the molars of that specimen are even lower than in *S. titan*, and the crowns of m. 1 and m. 2 are of remarkable shortness; while the latter tooth exhibits no trace of the complex pattern formed on the worn surface of the present specimens. These differences, together with the simple premolars of the female lower jaw of the present form, leave no doubt of the specific distinctness of the latter from the lower jaw figured in plate XI.: and since it has been shown even if that specimen do not belong to *S. giganteus* that the lower molars of that species must have been of very similar structure, there is no doubt of the specific distinctness of the present form from that species.

Compared with *S. cristatus*, the molars of the present specimens present a much greater resemblance than they do with those of *S. titan* or *S. giganteus*. In m. 3 of the living species the whole crown, and more especially the talon, is relatively lower; and the hindmost portion of the talon (*d*) comprises only a single column: the inner lateral surfaces of the main columns are less flattened and elongated, the accessory columns less fully developed, and the pattern on the worn masticating surfaces of all the molars less complex. With the simple molars of *S. barbatus* the present specimens have no resemblance.

Other mandibles.—In figs. 7, 7a of plate LXX. of the "F.A.S." there is represented, under the name of *S. giganteus*, the mandible of an immature Siwalik pig, now in the collection of the British Museum (No. 16,599), which, judging from the elongated form of m. 2 and the complex pattern of the worn surface of the same, as well as from the general contour of the jaw, should apparently be referred to the present species. The last molar is not fully protruded; and the small size of the canines indicates that the specimen probably belonged to a female. The side view shows the depression of the extremity of the symphysis below the alveoli of the cheek-teeth characteristic of this species. Another specimen in the same collection, represented in plate LXX., fig. 6, of the "F.A.S.," in which the molars are very much worn down and battered, probably belongs to the same species. The dimensions of these two specimens, taken in the same order, are as follows, *viz.*:—

Height of ramus at m. 3	2.0	2.1	*Width of m 1	0.55
Thickness „ „ „ „	1.4	1.4	Length „ „ 2	1.21
Length of symphysis	2.8	2.8	Width „ „ „	0.7
Interval between canine and pm. 1	0.5		Width „ „ 3	0.78
Length of m. 1	0.72			

A fragment of the right ramus of a mandible in the same collection (No. 16,609) probably belongs to a young individual of the same species. This specimen shows very clearly the elongated form of the little worn m. 1.

Distinctness and affinities.—The foregoing comparisons leave no doubt of the specific distinctness of the specimens under consideration from *S. giganteus* and

S. titan; and the resemblance of the different specimens to one another is so close that they may, at all events provisionally, be referred to a single species. That species is indeed a much smaller form than *S. titan*, and many of its individuals do not greatly exceed in size the existing *S. cristatus*. The fossil species is distinguished from all living species of the genus (including *Potamochoerus*) by the extreme complexity of the structure of its cheek-dentition, as well as by the form of the skull. In the latter respect it makes a very marked approach to *S. barbatus*, but the simple molar dentition of that species removes it very widely from the fossil. The only way of explaining the resemblance existing between the crania of these two forms seems to be that they may both be diverging branches from a common stock having a cranium of similar form, and with molars of the simple structure of the existing species.

With regard to the fossil species in the list on pages 51-2 the present form is at once distinguished from *S. antiquus*, *S. erymanthius*, and *S. major*, by the structure of its molars; those of the three fossil species being of the *S. titan* type. *S. arvernensis* is a much smaller form, with apparently simpler molars. The molars of *S. chæroides*, *S. chærotherium*, *S. lockharti*, and *S. palæochærus*, are all of a comparatively simple structure, and approach more or less closely those of *S. africanus* and *Hypotherium*; while none of the other species in the list appear to present any close resemblance to the present form. The distinctness of the latter from the Siwalik *S. hysudricus* and *Hippohyus* will be indicated in the sequel.

Seeing, therefore, that the specimens under consideration cannot be identified with any named species with which the writer is acquainted, they are entitled to rank as a distinct species, for which the name of *Sus falconeri* is proposed. There appears to be a certain amount of variation in the structure of the hinder molars, but not more than might be expected in different individuals of such a complex-toothed species. The high specialization of the species is indicated not only by the complex structure of the molars, but also by their extremely elongated form.

Resemblance to Phacochærus and Hippohyus.—Although there is no doubt that *S. falconeri* is a true *Sus*, yet in the structure of its molars it makes a decided approach to *Phacochærus*; this character being most marked in last lower molars, like the one represented in plate VII., figs. 2, 9. This tooth approaches m. 3 of *Phacochærus* in its extremely elongated form, in the flattened lateral walls of the main columns, in the distinctness and large size of the numerous accessory lateral columns filling the valleys, and in the relatively great height of the crown. To convert such a tooth into the lower molar of *Phacochærus*, it merely requires that the main columns should be reduced to the size of the accessory ones, and that each one should be completely isolated from the others, while the height of the crown should be still more increased. The last lower molar of *S. falconeri* is indeed almost exactly intermediate between the corresponding tooth of *S. titan* and *Phacochærus*; and it is thus easy to see how a transition may have taken place from a simple tooth like that of *S. titan* to the

extremely complex one of *Phacochærus*. In the "Enchainements" Prof. Gaudry remarks:—"Le genre *phacochère* a pu, comme celui des hippopotames, être cité parmi les formes qui sont isolées dans la nature actuelle, mais M. Tournouër m'a montré dernièrement des molaires d'un sanglier fossile recueilli en Afrique dans la province de Constantine, ou les denticules se multiplient et se séparant les uns des autres, de manière à indiquer une tendance vers la forme singulière des *phacochères*." This African form, which the writer believes to be still undescribed, would thus seem to be allied in the structure of its molars to *S. falconeri*; and it is interesting to find indications that the African wart-hogs were probably connected through an extinct North African form with a highly specialized true pig from the Siwaliks of India.

The complex structure of the molars of *Sus falconeri* leads on in another direction by an easy transition to the still more complex molars of *Hippohyus*, and it is thus, as will be shown in the sequel, easy to see how a transition may have been effected from the simpler forms of bunodont molars to those of the Selenodonts.

Distribution.—Remains of *S. falconeri* have hitherto been obtained only from the typical Siwalik Hills (unless some undetermined mandibles noticed in the sequel belong to this species). This is another instance of the more or less complete restriction of the more specialized forms to the eastern side of India: the more generalized forms usually characterizing the western side, although sometimes ranging to the eastward.

Species 4: *Sus hysudricus*, Falc. and Caut.

Syn. *Sus*, sp., Baker and Durand.

History.—At the conclusion of their memoir on the fossil Siwalik swine Baker and Durand² observed that an imperfect cranium, of which they gave a figure,³ indicated a species of Siwalik pig specifically distinct from the one they had first described (*S. falconeri*). They observed that this second species was of smaller size than the existing *S. cristatus*; and differed also, among other characters, by the more simple structure of the talon of m. 3. In the "F.A.S." a large number of specimens of the teeth and jaws of a small Siwalik pig were figured by Falconer and Cautley under the name of *S. hysudricus*; although no description of the species was ever published. A comparison of the figures shows that the species so designated is the same as the smaller *Sus* described by Baker and Durand.

Upper dentition and cranium.—In plate LXX., figs. 2, 2a, of the "F.A.S." there is represented the middle portion of a cranium of this species from the Siwalik Hills, in which m. 3 is not protruded, and the canine is of extremely small size; the latter character indicating that the specimen belonged to a female. A full-sized view of the dentition of this specimen is given in plate LXXI., fig. 9, of the same work. The pre-orbital concavity is narrow behind, as in *S. verrucosus*; and the form of the cranium appears to be relatively short and tall, as in the majority of existing

¹ "Mammifères Tertiaires," pp. 73-4.

² "Journ. As. Soc. Beng.," vol. V, p. 668.

³ *Ibid.*, pl. XLIV., fig. 6.

⁴ Part VIII., plates LXX., LXXI. (1847)

Asiatic pigs. In the specimen figured by Baker and Durand the canine is of large size, indicating a male individual: and from the width of the nasals it is inferred that this cranium was relatively shorter than that of *S. cristatus*. There is an imperfect cranium in the British Museum (No. 37,267) from the Siwaliks of Perim Island, in which the crowns of the teeth are broken off, exhibiting very similar characters.

In plate LXXI., fig. 5, of the "F.A.S." there is represented the left half of a palate of the same species, now in the British Museum, from Perim Island, showing the two last premolars and the three true molars, the last of which is unworn. A specimen of a fragment of the right maxilla, from the Siwalik Hills, represented in fig. 7 of the same plate, shows m. 2 and m. 3 in a well-worn condition. The specimen of a portion of the right maxilla represented in plate VIII., fig. 10, of the present volume was collected by Mr. Theobald in the Siwaliks of the Punjab, and exhibits the hinder portion of m. 1, and the complete m. 2 and m. 3; the latter being in an unworn condition. In fig. 11 of the same plate there is represented a fragment of the left maxilla, from the same region, showing the last premolar, and the first and second true molars; all in a well-worn condition. In the following table the dimensions of the four specimens mentioned above, taken in the same order, are compared with those of the corresponding teeth of a male of *S. andamanensis*, viz.:—

	<i>S. hyndricus</i>				<i>S. andamanensis</i>
Length of pm. 3	0.5				0.1
Width " "	0.35				0.33
Length " " 1	0.5		0.5		0.41
Width " " " "	0.53		0.56		0.45
Length " m. 1	0.6		0.64		0.67
Width " " "	0.55		0.6		0.48
Length " " 2	0.8	0.68	0.5	0.84	0.7
Width " " "	0.71	0.7	0.72	0.73	0.58
Length " "	1.1	0.85	1.2		0.95
Width " "	0.71	0.7	0.72		0.61

As the dimensions of the specimen figured by Baker and Durand, and those of the one represented in plate LXXI., fig. 9, of the "F.A.S.," are comprised within the same limits, it may be taken for granted that the foregoing dimensions indicate the average size of the species. The length of m. 1 in the third and fourth columns is practically the same as that of the corresponding tooth of the cranium of *S. cristatus* measured on page 55, but its width is greater. The last molar of the fossil is, however, very much shorter than in the last-named species; its length being less than that of the two preceding teeth. These two specimens indicate, therefore, an animal nearly as large as *S. cristatus*; but the specimen in the second column is more nearly the size of *S. andamanensis*. The extreme shortness of m. 3 distinguishes the fossil species from typical examples of *S. scrofa*, *S. verrucosus*, and *S. cristatus*; and allies it with *S. barbatus*, the typical form of *S. vittatus*, the *S. andamanensis* group, and the African river-hogs. The form of the cranium indicates that the fossil has no affinity with *S. barbatus*. In view of the uncertainty existing as to the relations of *S. vittatus* to the *S. andamanensis* group, it is almost impossible, when dealing with

fossil forms of intermediate size, to indicate any characters by which the one can be satisfactorily distinguished from the other; and comparisons will, therefore, be mainly confined to the *S. andamanensis* group. It may be observed, however, that the talon of the third molar of *S. andamanensis* is generally still simpler than that of *S. vittatus*; and the length of that tooth usually still less in proportion to that of the two preceding teeth; and that in this respect the fossil appears to be nearer to the former species. Compared with the cranium of *S. andamanensis*, the fossil form agrees with that species in the proportionate length of the true molars; the united length of m_1 and m_2 considerably exceeding that of m_3 , and the talon of the latter being relatively short: the true molars of the fossil are, however, relatively wider than those of the existing species. Both forms agree in the relatively early appearance¹ of m_3 ; but the crown of that tooth is lower in the fossil, and the talon wider, with its hinder portion (*b*) more distinctly separated from the hinder pair of main columns: the last tooth of the existing species has not the conspicuous cingulum of the fossil. The upper molars of *S. timorensis* and *S. papuensis* (the other members of the *S. andamanensis* group) are also very similar to those of the fossil, but have likewise slightly narrower and higher crowns. The crania of the three existing species have the pre-orbital concavity wide posteriorly. The last upper premolar of the fossil has its inner moiety longer antero-posteriorly, and its inner column (*a*) decidedly larger than in either of the three species mentioned, or indeed than in any existing Asiatic pig; and the preceding tooth² likewise appears to be relatively larger. In these respects the fossil is nearer to the African *S. porcus*³; which is, however, distinguished by the smaller relative size of m_3 , and the absence of pm_1 ; the latter being well developed in the fossil.

Lower dentition and mandible.—In plates LXX., LXXI., of the "F.A.S." there are represented five specimens of the mandible of a small species of Siwalik pig, which from their size and the structure of their teeth may be referred to the present species. The first specimen (plate LXX., figs. 3, 3a) shows the entire cheek-dentition of both sides, in an early stage of wear: the second (pl. LXXI., fig. 6) the cheek-dentition of the left side, the earlier premolars and m_3 being imperfect, and m_1 in a half-worn condition: the third (*ibid*, fig. 10) the last five teeth of the right side in a rather more worn condition: the fourth (*ibid*, fig. 8) m_2 and m_3 of the left side, in a well-worn condition; and the fifth (*ibid*, fig. 11) the symphysis, showing the four premolars. In plate VIII., figs. 3, 3a, of the present volume there is represented the dentition of the right ramus of a similar mandible collected by Mr. Theobald in the Siwaliks of the Potwár district of the Punjab, showing the last five cheek-teeth in a well-worn condition. In figure 2 of the same plate there is represented a fragment of the right ramus showing m_3 and the greater part of m_2 , both in a still

¹ The specimen represented in pl. LXXI., fig. 9, of the "F.A.S." is abnormal in this respect.

² "F.A.S.," pl. LXXI., fig. 9.

³ The upper and lower dentition of this form is figured by Rutimeyer in 'Verhand. nat. Ges. Basel,' vol. IV., p. 517, *et. seq.*, under the name of *S. parvillatus*.

more worn condition, obtained by Mr. Theobald from the Siwaliks of Lehri, Punjab. The corresponding portion of the opposite ramus of the same specimen was also obtained, but is not figured.

In the following table the dimensions of these seven specimens, taken in the same order, are compared with those of the mandible of *S. undamunensis*, viz.:—

	S. hysudricus.						S andamanensis.
Height at m. 2	2.0					2.1 2.3	1.4
Length of three molars	3.0	2.2				2.75	2.3
„ „ 6 cheek-tooth	4.88						3.5
„ „ pm. 2		0.45				0.45	0.4
„ „ 3	0.59	0.45				0.5 0.65	0.42
Width „ „ „	0.3				0.44	0.21	
Length „ „ 4	0.69	0.5	0.5	0.5 0.62		0.46	
Width „ „ „	0.43	0.35	0.35	0.5		0.32	
Length „ m 1	0.8	0.55	0.5	0.61		0.54	
Width „ „ „		0.43	0.4	0.48		0.37	
Length „ „ 2	0.92	0.7	0.66	0.73	0.84	0.65	
Width „ „ „		0.53	0.5	0.6	0.65 0.66	0.46	
Length „ „ 3	1.4	1.0	1.4	1.35 1.28		1.1	
Width „ „ „			0.5	0.65	0.7 0.71	0.53	
„ „ intermolar space at pm 2		1.3				0.96	

The differences in these dimensions are not greater than those which might occur in different individuals of the same species: the excessive length of $m.1$ and $\bar{m}.2$ in the first specimen is due to the large talons and early stage of wear of those teeth. In all the specimens the united length of $m.1$ and $\bar{m}.2$ largely exceeds that of $\bar{m}.3$. The specimen in the sixth column (pl. VIII., fig. 3) may, from the large size of the premolars, be pretty safely referred to a male. It will be seen from the dimensions that in this specimen $\bar{pm}.3$ and $\bar{pm}.4$ are much larger in proportion to $\bar{m}.1$ than in *S. andamanensis*; this being especially marked in the case of $\bar{pm}.3$, whose length exceeds that of $m.1$, instead of being considerably less: both premolars are relatively much wider than in the existing species; but $\bar{pm}.3$ appears to have been inserted by two roots only. It seems that the accessory inner column (*a*) found in $\bar{pm}.4$ of *S. titan* (pl. VII., fig. 4) is developed in the corresponding tooth of the present species. In some of the specimens figured in the "F.A.S." the premolars are relatively smaller; whence it is not improbable that those specimens belonged to females. The true molars are very similar in structure and proportionate size to those of *S. andamanensis*, but the crowns are somewhat lower; and the talon* of $m.3$ has its posterior portion (*b, c*) more distinctly separated from the middle accessory column (*a*). In the jaw referred to a male the molars are relatively rather wider; but this is not the case with some of the specimens figured in the "F.A.S.," which may belong to females. Very similar differences obtain between the fossils and the lower molars of *S. papuensis*.

In the specimen represented in plate VIII., fig. 3, the depth of the jaw and the length of $\overline{m.1}$ and $\overline{m.2}$ is almost exactly the same as in the jaw of *S. cristatus* measured on page 73; but the width of these two teeth is considerably greater in the fossil; while the length of $\overline{m.3}$ is much less, and that of $\overline{pm.3}$ and $\overline{pm.4}$ as much

¹ A last lower molar of *S. andamanensis* is figured on an enlarged scale by Rolleston, *op. cit.*, pl. XLIII., fig. 8

greater. This specimen, therefore, indicates an animal as large as *S. cristatus*; but other specimens scarcely exceed the size of *S. andamanensis*.

In its relatively large hinder premolars the mandible represented in plate VIII., fig. 3, is like that of *S. porcus*¹; but pm. 3 is longer, instead of shorter, than pm. 4 in the fossil; and the two preceding teeth are well developed. In the large size of the hinder premolars in both jaws the fossil is distinguished from *S. vittatus* as markedly as from the *S. andamanensis* group.

In plate VIII., fig. 5, there is represented a fragment of the right ramus of the mandible of a young pig, collected by Mr. Theobald in the Siwaliks of the Punjab, containing the last milk-molar (mm. 4) in a half worn condition, and m. 1 in an early stage of wear: from the size of the latter tooth the specimen may be referred to the present species. The milk-molar agrees very closely with the same tooth in a young English domestic pig. In fig. 6 of the same plate there is represented the corresponding portion of a left ramus, obtained by Mr. Theobald from the Siwaliks of Kúshalghar, below Attock, containing the homologous teeth. The milk-molar is broken and very much worn: m. 1 is slightly smaller than in the last specimen, and indicates a small individual of the species. In fig. 8 of the same plate there is represented a fragment of the right ramus of the mandible of an extremely young individual, also from the Siwaliks of the Punjab, containing the third and fourth milk-molars in an unworn condition. The dimensions of the teeth of the three specimens described above (taken in the same order) are given in the following table, viz.:—

Length of mm. 3			0 16
" " " 4	0 68		0 72
Width " " "	0 34	0 32	0 36
Length " m. 1	0 61	0 58	
Width " " "	0 44	0 11	

Specific distinctness and affinities.—The foregoing comparisons indicate that the present form is specifically distinct from any existing pig, and that it appears to be most nearly allied to the *S. andamanensis* group; but is distinguished from the living representatives of that group, among other characters, by the proportionately larger and stouter premolars, and the wider and lower-crowned molars of the male sex; most individuals of which were of larger size than the existing species. In the form of the premolars it shows some affinity to the African river-hogs.

Turning to the previously described Siwalik species, the present form is at once sufficiently distinguished from *S. falconeri* by its much simpler last molars. In the structure of its cheek-teeth it is much nearer to *S. titan*, but is sufficiently distinguished by its greatly inferior size. The last upper molar (pl. VIII., fig. 10) is of the same general form as that of *S. titan* (pl. VII., fig. 6), but the hinder part of the talon (*b*) is narrower, the valleys are less open, the accessory columnus in the neighbourhood of the talon more numerous, and the enamel thrown into a greater number of corrugations. The lower molars of the two are likewise very similar

¹ Vide Rutimeyer, *op. cit.*

(pl. VIII., fig. 3, and pl. VII., fig. 4), but it is difficult to compare them exactly, owing to their different degrees of wear. The talon of $\overline{m.3}$ of the present form seems to have had lower columns, less distinctly separated from one another, than in *S. lilan*. In no individuals of the latter were the hinder lower premolars relatively as narrow as in some (female) individuals of the present form. From *S. giganteus* the present form is equally well distinguished by its inferior size. The last upper molar of that species (pl. XI., fig. 2) has no sign of the cingulum which is so conspicuously developed in the corresponding tooth of the present form: and the first and second molars are usually still wider in proportion to their length. Finally the teeth of the lower jaw provisionally assigned to that species (pl. XI., fig. 1) are of a totally different type from those of the present form.

It may accordingly be taken as pretty evident that the present form is specifically distinct from either of the three species of Siwalik pigs already described, and it now remains to compare it with the fossil species of Europe. It will probably suffice to state that the forms coming nearest to the Siwalik fossil are those grouped in the table on pp. 51-2 under the names of *S. chavroiles*, *S. lockharti*, and *S. palaeochærus*. The lower jaw figured by Kaup¹ under the latter name in having relatively large premolars is very similar to the specimen represented in plate VIII., fig. 3: its $\overline{m.1}$ and $\overline{m.2}$ are, however, rather more elongated, but as this character is not constant in the specimens referred to the present species it cannot be regarded as of specific value. The last upper molar of the same species figured by Kaup² is also very similar to the corresponding tooth of the specimen in plate VIII., fig. 10, although its talon is placed directly in the median line. The above-mentioned specimens come nearer to the Siwalik form than any others which have come under the present writer's notice; and the resemblance is indeed so close that it appears quite possible that the two may be specifically identical. Bearing in mind, however, the extreme difficulty of distinguishing allied species of the genus from the characters of their molars, it would be rash to say that the European and Indian forms are the same; and it, therefore, seems best that the name of *S. hysudricus*³ should be, at least provisionally, retained for the latter.

Distribution.—Remains referable to *S. hysudricus* have been obtained from the typical Siwalik Hills, from the Siwaliks of the Punjab and Perim Island, and from the lower Siwaliks of Sind. The latter circumstance is of importance, since it is from the western side of India that species closely connected with European forms usually occur.

Species 5: *SUS PUNJABIENSIS*, *nobis*.

History.—In 1878 the present writer⁴ gave a preliminary description of a fragment of the mandible⁵ of a small Siwalik pig, which was referred to a new species under the above name.

¹ "Beilage," pt. IV., pl. VI., figs. 1, 1a

² *Ibid*, fig. 2

³ The name *S. palaeochærus* was published in 1833, and *S. hysudricus* in 1847

⁴ 'Records,' vol. XI, p. 81

⁵ In the original notice two specimens are mentioned: the second (pl. VIII., fig. 6) belongs, however, to a young individual of *S. hysudricus*

Mandible.—The dentition of the above-mentioned mandible is represented in plate VIII., figs. 9, 9a. The specimen, which was obtained by Mr. Theobald from the Siwaliks of Asnot, consists of the hinder dental portion of the left ramus, and contains the three true molars; of which the first is well-worn, and the third only touched on its anterior columns. The dimensions of the specimen are as follows, viz.:—

Length of three molars	1 46	Width of m 2	0 35
„ „ m 1	0 32	Length „ „ 3	0 61
Width „ „ „	0 29	Width „ „ „	0 38
Length „ „ 2	0 49	Depth of jaw at ditto	0 69

The condition of the teeth shows that the specimen belonged to an adult animal; and if the foregoing dimensions be compared with those of the mandible of *S. hysudricus* given on page 80, it will be seen that the present specimen is so much smaller than the smallest individual of that species, that on this ground alone there would be every reason for referring the former to a distinct species. There are, however, such differences in the last molars as to render the distinctness of the two beyond reasonable doubt. In m. 3 of the present form the talon is relatively much shorter and higher than in *S. hysudricus* (compare plate VIII., figs. 9a, 3a); its length being less, instead of exceeding, that of the second main column; and its height being nearly equal to the latter. All the columns of the tooth are, moreover, relatively higher in the present specimen, and they are more closely squeezed together. These differences in form and size are of such importance as to leave no reasonable doubt of the specific distinctness of the present minute form from *S. hysudricus*; and it is quite evident that it cannot belong to either of the other larger Siwalik species.¹

The present specimen agrees very closely in size with the mandible of *S. salvanus*²; but is distinguished by the earlier protrusion of m. 3 (which is exceptionally late in the pigmy-hog), and by m. 1 and m. 2 being relatively wider³: the pattern on the worn crowns is very similar in the two forms. All other existing species are of far larger size. Of the fossil species mentioned on pp. 51-2 apparently the only one approaching in size to the present form is *S. valentini*, which is, however, still larger. The lower jaw of that species is unknown; but judging from the description of the upper teeth it is unlikely that it should be specifically the same as the present form.

Distinctness and affinities.—It appears, therefore, that the present specimen indicates the existence in the Siwaliks of a diminutive species of pig, not larger than the existing pigmy-hog of the Nepal terai. As it cannot be identified with that species, and is apparently smaller than any other described form, it may be regarded as specifically distinct, and may be known as *S. punjabensis*.

¹ The distinction between the specimen and *Saurotherium schlegelensis* (*Sus pusillus*, Falc.) will be noticed under the head of that species.

² Brit Mus., No B 1077a.

³ The second molar of the fossil is both shorter and wider than m. 2 of the existing species.

That *S. punjabiensis* may be regarded as the ancestor of *S. salweenius* is highly probable, both from its occurrence in the same country, from its size, and from the circumstance that in its lower molars it presents evidence of being a somewhat more generalized form.

The existence of the present pig, which was not larger than a hare, side by side with the larger race of the colossal *S. titan* (compare pl. VII., fig. 3, with m. 3 of plate VIII., fig. 9), which rivalled the hippopotamus in size, is very noteworthy, and indicates very clearly the luxuriance of the mammalian life of the Siwalik epoch.

UNDETERMINED SPECIMENS.

Part of mandible from the Punjab.—In¹ figs. 1, 1a of plate VIII. of this volume there are given two views of the symphysial extremity of the left ramus of the mandible of a large pig collected by Mr. Theobald in the Siwaliks of the village of Asnot, Punjab, which does not agree with any of the specimens described above. The fragment shows the broken canine, the bases of $\overline{\text{pm. 1}}$ and pm. 2 , and the complete pm. 3 and pm. 4 : the last tooth alone is slightly worn. The triangular section, and comparatively large size of the canine indicates that the specimen belonged to a male. The first premolar is nearly as long as the second, and is closely approximated both to the latter and to the canine, so that there is scarcely any diastema. The dimensions of the specimen are as follows, *viz.*:—

Interval between canine and pm. 2	0.56	Width of pm. 3	0.5
„ „ „ pm. 1 and pm. 2	0.2	Height „ „ „	0.91
Length of pm. 1 (alveolus)	0.55	Length „ „ „	0.81
„ „ „ 2 (ditto)	0.61	Width „ „ „	0.75
„ „ „ 3	0.92	Long diameter of canine	0.85

This jaw differs from the mandible of *S. titan* figured in plate IX. by the large size of pm. 1 and by the shortness of the interval between that tooth and pm. 2 ; and from the mandibles of the same species represented in plates VII., fig. 4, and VIII., fig. 1, by the absence of the inner column (*a*) in pm. 4 , which is constantly present in all the known jaws of that species. The two last premolars are very different from the corresponding teeth of the mandible figured in plate XI., fig. 1, under the name of *S. giganteus*; this difference being especially marked in the case of pm. 3 . These differences are so great that it may be pretty safely concluded that the specimen does not belong to either of the two species mentioned. The above-mentioned teeth are of the same general form as those of the female mandible of *S. falconeri* represented in plate VII., fig. 1, but are of very much larger size: in that specimen pm. 1 is of relatively smaller size than in the present jaw, and is separated by a considerable interval from pm. 2 . In the male lower jaw of that species figured by Baker and Durand,¹ the dimensions of the premolars are as follows, *viz.*:—

First premolar	0.35 X 0.2	Third premolar	0.62 X 0.36
Second ditto	0.5 X 0.27	Fourth ditto	0.7 X 0.51

It appears from these dimensions that the teeth are considerably smaller than

¹ *Op. cit.*, plate XXXV., fig. 3.

those of the present specimen; $\overline{\text{pm. 1}}$ being also smaller as compared with $\overline{\text{pm. 2}}$, and, judging from the figure, being separated by a considerable interval from that tooth.

The present specimen is of far too large a size to have belonged to either of the other two species of Siwalik pigs. It requires, however, the evidence of the true molars before it can certainly be determined that it does not belong to a large race of *S. falconeri*, but it is highly probable that it does not. Should, however, later discoveries indicate that it does belong to that species, then there will be good evidence that a few individuals of the latter ranged into the Punjab. If, as seems probable, it is specifically distinct from *S. falconeri*, the present specimen indicates a sixth species of Siwalik pig.

Mandible from the Narbadas.—In plate LXX., figs. 8, 8a, of the "F.A.S." there is represented under the name of *S. giganteus* the nearly complete mandible of a pig from the Narbadas, which is now in the British Museum (No. 36,843). The whole of the teeth are preserved, $\overline{\text{m. 3}}$ being in an early stage of wear, although fully protruded: the small size of the canines probably indicates that the specimen belonged to a female. Its dimensions are as follows, viz.:—

Length of last five teeth	4 6	Length of $\overline{\text{m. 2}}$	1 0
" " three true molars	3 4	Width " " "	0 72
" " $\overline{\text{pm. 3}}$	0 64	Length " " 3	1 7
" " $\overline{\text{m. 1}}$	0 60	Width " " "	0 89
Width " " "	0 53	Long diameter of canine	0 75
Length of symphysis		1 0	

These dimensions indicate an animal of about the size of the female of *S. falconeri*, and it is evident from the structure of the cheek-teeth that it is only with that species among the Siwalik forms that the specimen can be compared. In specimens of *S. falconeri* with the teeth in about the same stage of wear $\overline{\text{m. 2}}$ and $\overline{\text{m. 3}}$ are usually longer and narrower; and the complexity of the pattern on their worn surface appears decidedly greater. The inner columns of the molars of the Narbada jaw apparently have their inner surfaces less flattened: but the talon of $\overline{\text{m. 3}}$ seems to have the same number of columns, although these are relatively smaller. The incisive alveoli of the specimen are less depressed below the level of the molar series than in *S. falconeri*, and the inferior border of the symphysis is inclined more rapidly upwards. Although these differences appear comparatively slight, yet it is not improbable that they may be of specific value; and it is highly likely that the fossil pig of the Narbadas may have been more closely related than any of its Siwalik congeners to existing Asiatic species like *S. cristatus*.

GENUS II.: HIPPOHYUS, Falc. and Caut.¹

The history of the genus is given under the head of the species.

Species: *HIPPOHYUS SIVALENSIS*, Falc. and Caut.

Synonym. *Sus (Hippohyus) sivalensis*, Falc. and Caut.

History.—Apparently the first published mention of this genus and species occurs in Sir R. Owen's "Odontography"² (1840-5), where an upper molar is

¹ In Owen's "Odontography," p. 562 (1840-5). It seems best on the whole, as in the analogous case of *Hyaenarctos*, to authenticate the genus as above: it might, however, be given as 'Owen (or Falc. and Caut.)' in which case the same would have to be done with *Hyaenarctos*.

² Loc. cit.

figured¹ under the name of *Hippohyus sivalensis*, which was probably at that time a manuscript name of Falconer and Cautley's; and it is stated that the structure of the upper molars makes an approach to that of the same teeth in the hippopotamus.² In the 8th part of the "Fauna Antiqua Sivalensis"³ (1847) a skull and three fragments of the mandible are figured under the name of *Sus* (*Hippohyus*) *sivalensis*; while in the notice of the Siwalik fauna in the "Palæontological Memoirs,"⁴ compiled from Falconer's notes and letters, *Hippohyus* is alluded to as a distinct genus. It thus seems doubtful whether this name was intended by its founders to be used in a generic or subgeneric sense: the peculiar character of the dentition leads, however, to the conclusion that it should be used in the latter sense, although there are not wanting signs of a transition from this genus to *Sus*. Beyond the brief notice by Sir R. Owen no description of the type species has ever been published. The present writer has recorded⁵ the occurrence of the genus in the Siwaliks of the Punjab, and indicated the possibility of some of these remains belonging to a second species.

Cranium and upper dentition.—Three views ($\frac{1}{2}$) of the type cranium, which is in the British Museum, are given on plate LXX. of the "F.A.S.," and the dentition of the right side (reversed) is represented of the full size in fig. 1 of the succeeding plate. With the exception of the loss of the zygomatic arches, the extremity of the premaxillæ and a portion of the occiput, the specimen is in excellent preservation: it shows the alveoli of three incisors, of the canine, and of the first and second premolars; the remaining five teeth are in position, but m. 3 is not fully protruded, which indicates the sub-adult condition of the specimen. In the following table its dimensions are compared with those of a male skull of *Sus andamanensis*, viz.:—

	Hippohyus.	Sus.
From occipital condyle to anterior border of incisive alveolus	9.0	8.9
„ lower border of foramen magnum to posterior border of palate	2.3	2.4
„ posterior border of palate to posterior border of incisive foramen	5.4	5.16
Transverse diameter of both condyles	1.88	1.56
Length of palate	6.3	6.2
„ „ series of cheek-teeth	1.3	3.54
„ „ palate in front of pm. 1	1.9	2.61
Width of intermolar space at m. 2	1.2	0.88
„ „ palate at canines	1.05	1.0
„ „ „ „ i. 2	0.7	0.6
Length of three true molars	2.7	2.2
Interval between pm. 1 and pm. 2	0.2	0.0
Length of pm. 3	0.5	0.4
Width „ „ „	0.4	0.33
Length „ „ 4	0.5	0.44
Width „ „ „	0.5	0.45
Length „ „ m. 1	0.6	0.57
Width „ „ „	0.6	0.48
Length „ „ 2	0.9	0.7
Width „ „ „	0.8	0.58
Length „ „ 3	1.15	0.95
Width „ „ „	0.8	0.61
Interval between i. 3 and pm. 3	0.6	1.30

¹ Plate CXI., fig. 7.

² It is very doubtful whether the name *Hippohyus* was intended to indicate affinity with the hippopotamus, or with the horse, to the molars of the latter of which those of this Siwalik pig present a distant resemblance in the pattern of their grinding surface.

³ Pls. LXX., LXXI.

⁴ Vol. I., p. 22.

⁵ 'Records,' vol. XI., p. 82.

The general form of the skull is essentially that of a pig: the frontals are, however, unusually flat, and the nasals wide; while the contour of the masticating surface of the series of cheek-teeth is more convex than in any pig: the palate extends a considerable distance behind m.3. The foregoing dimensions show that in general size the Siwalik skull belonged to an animal considerably larger than the Andamanese pig; although in some of its dimensions it is smaller than the latter. Thus the portion of the palate in front of pm.1 is very considerably smaller than in *S. andamanensis*; indicating that this part of the skull is considerably shorter in proportion to the portion behind pm.1 than in that species of *Sus*, which is one of those having relatively short nasals. This shortness is caused by the small size of the canine (the alveolus¹ of which is not larger than that of i.2), and the absence of any diastema between it and i.3; the presence of which forms such a marked feature in all species of *Sus*. The canine was evidently a small incisor-like tooth, which did not project outwardly beyond the incisors. The third incisor (i.3) is larger than in *Sus*, and is in close apposition to the preceding tooth: i.1 is larger than either of the other teeth of that series. In all these distinctive points the Siwalik skull agrees precisely with *Hypotherium*.² The anterior portion of the palate is vaulted, as in that genus and *Sus*; but the anterior palatine foramina are apparently somewhat smaller than in either of those genera, and thereby make some approach to *Dicotyles*.

In the Indian Museum there are two imperfect crania (Nos. B. 62, 63), collected by Mr. Theobald in the Siwaliks of the Punjab, agreeing in all essential points with the type specimen. The second of these specimens shows the excessive width of the nasals, and the extremely small size of the alveolus of the canine: the length of the series of cheek-teeth is only 3.9 inches; and it is possible that these specimens may indicate a smaller race, or even species.

The upper cheek-dentition is described by Sir R. Owen³ in the following words: "Each upper true molar has its crown cleft by the common or crucial valleys, the transverse one passing from within forwards and outwards. Each of the four principal lobes is subdivided, not by a vertical central depression, but by a fold penetrating its anterior and posterior margins: the enamel at first shows additional minor plications; but is worn down progressively to the simpler pattern above described: the outer lobes are convex externally. The first premolar is very small and simple, separated by an interval of its own breadth from the second: both this and the third have transversely compressed crowns, the fourth has a sub-trihedral crown."

In plate XII., fig. 17, there is represented a fragment of the right maxilla, collected by Mr. Theobald in the Siwaliks of Asnot, showing m.2 and m.3, and belonging to an older individual than the type specimen. The last molar is fully protruded and partially worn; and m.2 about half worn. In fig. 21 of the same plate there are represented the corresponding teeth from a palate specimen, also

¹ This alveolus is the hollow immediately in advance of pm.1 in the figure in plate LXXI., fig. 1, of the "F.A.S."

² E.g. *H. uatouhoust*, vide Filhol. 'Ann. Sci. Geol.,' vol. XI, pl. VI

³ *Op. cit.*, p. 562

collected by Mr. Theobald in the Punjab. In this specimen the teeth are still more worn; m. 2 being reduced to a plain surface of dentine, and m. 3 about half worn. There is another very similar specimen in the Indian Museum (No. B. 67), from the same locality. The following table gives the dimensions of these three specimens, taken in the same order:—

Length of <u>m.</u> 2	0.9	0.88	0.77
Width		0.86	
Length „ „ 3	1.48	1.43	1.22
Width „ „ „	0.99	0.93	0.79
„ „ intermolar space at <u>m.</u> 2		1.36	1.34

These dimensions are so near to one another that all the specimens may be provisionally classed together, although it is not impossible that they may belong to more than one species. It will be seen from the figures that the talon of m. 3 is relatively short, and corresponds with that of the homologous tooth of *S. titan* (pl. VII., fig. 6); consisting in an early stage of wear (pl. XII., fig. 17) of a hinder portion (*b*), and a median column (*a*). The same figure shows the correspondence between the other portions of the tooth and the molar of *S. titan*. Thus there are in each tooth four main columns with three accessory columns (*a*, *g*, *h*) in the median line: at a later stage of wear (pl. XII., fig. 21) the accessory median columns unite with the inner main columns (as is the case in *Sus*), and produce the complicated pattern characteristic of the genus. The difference between the molars of *Hippohyus* and *Sus titan* consists in the columns of the former being taller, more elongated antero-posteriorly, with their outer walls more flattened, and the foldings of the enamel much deeper; by which means the valleys are made very deep, narrow, and sinuous. The molars of *S. falconeri* (pl. VII., fig. 5)¹ are in some respects intermediate between the two, and easily show the manner in which the transition has taken place. The third molar of the last-named species is widely distinguished by its very complex talon; and the columns of all the molar teeth have been more squeezed together, so that the valleys are to a great extent obliterated.

Mandible and lower dentition.—In plate LXXI., figs. 2, 3, 4, of the “F.A.S.” there are represented three fragments of the mandible and lower dentition of a pig-like animal, which from the structure of the teeth undoubtedly belongs to the present form. The first specimen shows m. 3 and a part of m. 2; the second m. 1 and m. 2, the former much worn; and the third the same teeth in a less worn condition: all three specimens came from the Siwalik Hills, and are now in the British Museum. The following table shows the dimensions of their teeth, *viz.*:—

Length of <u>m.</u> 1	0.5	0.55
Width „ „ „	0.45	
Length „ „ 2	1.0	0.85
Width „ „ „	0.63	
Length „ „ 3	1.16	
Width „ „ „	0.73	

In plate XII., fig. 3, of the present volume there are represented the hinder cheek-teeth of the right ramus of a mandible collected by Mr. Theobald in the Siwaliks of

¹ In the upper molars of *S. falconeri* the letters *f*, *g* correspond to *g*, *h* in those of the present species

Kolsa, Punjab: the corresponding fragment of the left ramus was obtained at the same time, as well as the extremity of the symphysis, one half of which is represented in fig. 19 of the same plate. The first and second molars are much worn, and $m.3$ is about half worn down, showing that the specimen belonged to an aged animal. The structure of $m.3$ shows that the specimen belonged to the present form; and the dimensions of the teeth indicate an individual of about the same size as that to which the upper molars represented in fig. 17 belonged: the great width of the teeth probably indicates that the specimen belonged to a male. In fig. 18 of the same plate there is represented a fragment of the left ramus of a somewhat similar mandible, from the Punjab, containing a fragment of $m.2$, and $m.3$ imperfect on the outer side: this tooth is almost unworn, and from being slightly smaller and relatively rather narrower than the corresponding tooth of the last specimen it is probable that the present specimen belonged to a female individual. In figs. 20 and 4 of the same plate there are represented two fragments of the left ramus of mandibles of a species of the present genus; also from the Siwaliks of the Punjab. The second of these specimens contains the three true molars, and a fragment of $pm.4$; whilst the first contains $m.3$ and a part of $m.2$, these teeth being rather more worn than in the first specimen. The teeth of the specimen represented in fig. 4 agree in relative size with those of one of the small crania in the Indian Museum noticed on page 87 (No. B. 63), and from the great difference in size between them and the teeth of the specimen represented in fig. 3 it is quite possible that the present specimen and the crania belong to a small form, which may be specifically distinct from *H. sivalensis*. There is, however, such an amount of variation in the size of the different specimens, which apparently present no distinctive structural points, that nothing would be gained by attempting to separate them. The dimensions of the teeth of the four specimens described above (taken in the same order) are as follows, *viz.*:—

Length of $m.2$	.	.	.	.	.	.	0.86		0.71
Width „ „ „	.	.	.	.	.	.	0.7	0.59	0.5
Length „ „ 3	.	.	.	.	.	.	1.77	1.6	1.35
Width „ „ „	.	.	.	.	.	.	0.8	0.68	0.6
									0.53

In structure the lower molars are precisely analogous to the upper; but the talon of $m.3$ is perhaps rather larger in proportion to that of $m.3$ than is usually the case in true pigs. In the number of the columns composing its talon $m.3$ (pl. XII., fig. 18) corresponds with *Sus tilan* (pl. VII., fig. 4) rather than with *S. falconeri* (*ibid.*, fig. 2). A comparison of the figures will show how $m.3$ is formed by an amplification of the plan of that of the corresponding tooth of *S. tilan*, in the same way as has been shown to be the case with $m.3$; the tooth of *S. falconeri* being in some respects intermediate.

The symphysis belonging to the first of the foregoing specimens, of which the left side is represented in fig. 19, shows the three incisors, and the broken bases of the canine and $pm.1$. The latter was inserted by a compressed conjoint fang, and was evidently relatively larger than in *Sus*; it is separated by a very short interval both from $pm.2$ and the canine. The canine (*c*) is not of larger diameter than the

second incisor, and its crown was in all probability not produced much above the level of the incisors: it is in immediate contact with $\bar{i}.3$, the base of the latter being indented by the canine. The incisors are all much worn; and are directed considerably more upwardly than in *Sus*. The first incisor ($i.1$) is a narrow compressed tooth, of much the same form as in that genus. The second incisor is much larger than the first, and its crown is greatly expanded laterally towards the summit: in general form it is more like the corresponding tooth of a ruminant than of *Sus*. The third incisor is considerably smaller than the second, but had a similarly expanded crown, and is likewise more like the corresponding tooth of a ruminant than a pig. In the absence of any diastema the present specimen resembles *Hyootherium*¹; as it does in the expanded crown of $\bar{i}.3$, and the curved form and upward direction of all the incisors. The large size of $\bar{i}.2$ and its expanded crown are, however, characters not found in *Hyootherium*; and are very decided ruminant characters. The form and direction of the incisors clearly indicates that *Hippohyus* was an animal more adapted for grazing than the true pigs:—a conclusion fully borne out by the characters of the molars.

Affinities.—The foregoing comparisons indicate pretty conclusively that the present form is generically distinct from *Sus*. In certain cranial characters, and in the arrangement of the teeth the genus shows strong indications of affinity with *Hyootherium*. In the structure of its molars it is, however, widely different from that genus; species of *Sus* with comparatively simple molars, like *S. titan*, occupying in this respect a middle position between *Hyootherium* and *Hippohyus*. The true molars present a very considerable resemblance to those of *Hippopotamus*, but are widely distinguished by the equal development of the longitudinal and transverse valleys, in place of the diminution of the former and the enlargement of the latter. There is a distant resemblance to the molars of the horse in those of the present genus, which cannot, however, be taken to indicate any affinity between the two: if the generic name was assigned from this resemblance it is a highly objectionable one.

In another direction the molars of *Hippohyus* make a decided approach to those of some of the selenodont Artiodactyla. Thus if the upper molars of simple selenodonts like *Hemimeryx* or *Hypopotamus*² be compared with those represented in plate XII., fig. 17, it will be seen that the plan of structure is essentially the same in the two; the median columns a , g , h , in the *Hippohyus* molar corresponding to the extremities of the crescents of the selenodont tooth. The molars of *Hippohyus* are, however, less like those of the ruminants than are those of *Hemimeryx*, and are of far too complex structure to be on the ancestral line of that genus; whence it is probable that *Hippohyus* may be regarded as an offshoot from a pig-like stock which has died out without descendants.

Distribution.—Remains of *Hippohyus* have been obtained from the typical Siwalik Hills and from the Punjab. The smaller form comes solely from the Punjab.

¹ Vide Filhol, 'Ann. Sci. Géol.', vol. XI, pp. 21-3, pl. VII.

² *Synapsa*, vol. II, pl. XXIII.

GENUS III.: SANITHERIUM, H. von Meyer.

Species: SANITHERIUM SCHLAGINTWEITI, H. von Meyer.

Syn. *Sus pusillus*, Falconer.

Mandible.—This genus and species are founded on some fragments of the mandible and lower molars of a small pig-like animal, obtained from the Siwaliks of Kúshulghar, Punjab, which have been already described and figured in the first volume.¹ One of these specimens (the original of *Sus pusillus* of Falconer) has, however, been refigured in plate VIII., fig. 7, of this volume in order to show its distinctness from the mandible of *Sus punjabiensis* (*ibid*, fig. 9), with which it agrees very closely in size. The specimen consists of a fragment of the right ramus, containing the third true molar in an early stage of wear, of which the anterior columns have been broken off. It will be seen that this tooth differs from the last molar of *Sus punjabiensis* by the presence of a distinct cingulum on the outer side of the second main outer column; and by the very large development of the two hind columns (*b*, *c*) of the talon, as well as by the union of the median accessory column (*a*) with the outer main column of the tooth; the other median accessory column (*e*) being likewise united with the same main column. A comparison of the *Sanitherium* molar with the corresponding teeth of *Hippohyus* figured in plate XII. will show that in all these respects, as well as in the compression of the main inner columns, there is a much closer resemblance between the two than there is between *Sanitherium* and *Sus*. The tooth of *Hippohyus* is, however, unprovided with the cingulum which forms such a marked feature in *Sanitherium*.

These comparisons indicate that the latter genus (as far as the very slight materials on which it is founded admit of its characters being defined) is more nearly allied to *Hippohyus* than to *Sus*.

GENUS IV.: HYOTHERIUM, H. von Meyer.

Syn. *Amphichærus*, Brav. (?) MSS.; *Chæromorus*, Gervais, *et* Lartet, MSS.; *Chærotherium*, Lart.; *Palæochærus*, Pom.

Synonymy.—The name *Hyootherium* was applied in 1834 by H. von Meyer² to *H. sæmmeringi*. In 1846 Pomet³ founded the genus *Palæochærus*, with the two species *P. typus* and *P. major*. In 1851 the name *Chærotherium* was applied by Lartet⁴ to several species, one of which was named *C. sansaniense*; and apparently about the same time Lartet's manuscript name *Chæromorus* was employed by Gervais⁵ for two forms which he named *C. simplex* and *C. mammilatus*. The name *Amphichærus*, Bravard, is applied to certain specimens in the British Museum. In 1859 Gervais⁶

¹ Page 76 (58), pl IX, figs 6-9.² "Die fossile Zähne und Knochen von Georgensmund," p. 43, pl. II.³ "Bull. Soc. Geol. France," 2nd ser., vol. IV, p. 381, pl. IV.⁴ "Notice sur la Colline de Sansan," p. 32.⁵ "Zool. et Pal. Franç.," 1st ed. (1848-52), p. 198, note 1, and explanation of plate XXXIII, p. 7.⁶ *Ibid*, 2nd ed., p. 182.

came to the conclusion that all the above-mentioned names were really synonymous; and adopted the name *Hyotherium*, which has the priority. The same view was subsequently adopted by Peters¹; but Prof. Gaudry² retains the two genera *Hyotherium* and *Palæochærus*; although admitting that there is practically no distinction between them.³ The former view will be adopted in this memoir.

Number of species.—There is such utter confusion in the species of the genus that without an actual comparison of all the types it is impossible to arrive at any satisfactory conclusion; and the following list of the non-Indian forms must be regarded as purely provisional: the most doubtful species are indicated by an asterisk.

*1. *HYOTHERIUM MEDIUM*, H. Meyer.⁴ Miocene, Germany.

An insufficiently described species, whose claim to distinction is considered very doubtful by Peters.⁵

2. *HYOTHERIUM MEISSNERI*, H. Meyer.⁶ Miocene, Germany.

Charopotamus meissneri, Meyer⁷ (1834). *Sus meissneri*, Kaup.⁸

A species nearly equal in size to *H. typus* (with which it is identified by Peters⁹); but apparently distinguished by its more elongated upper true molars, in which the cusps are less distinct than in that species.¹⁰ The lower jaw figured by Gervais¹¹ under the name of *Charomorus simplex*, and referred by Peters to the present species, is apparently distinct from the type mandible of *H. meissneri*. If *H. meissneri* and *H. typus* are really synonymous the former name has the priority.¹²

*3. *HYOTHERIUM MINIMUM*¹³ (Cuv.). Miocene, France.

Sus leptodon, Pom. (teste Gastaldi).

(?) *H. cuvieri*, Pet. *Anthracotherium minimum*, Cuv.

This species is referred to *Hyotherium* on the authority of Gervais,¹⁴ who figured a lower jaw belonging to an animal rather larger than a peccary: the molars seem to have a tendency to a selenodont structure which is wanting in other forms. It appears that Peters¹⁵ confused this species with *Anthracotherium minutum*, Blain.¹⁶; since when mentioning that name he refers to Gervais' figure of *H. (A.) minimum*. In the mandible figured by Gastaldi the columns appear more conical.

1 'Donschr. k. Ak. Wiss.,' vol. XXIX, p. 196, et. seq., 1869.

2 'Les Enchainements—Mam. Tert.," p. 71.

3 It is somewhat difficult to ascertain Dr. Filhol's views: in one memoir ('Ann. Sci. Géol.,' vol. XI.) he apparently uses the name *Hyotherium* in its widest sense; but in another ('Phosphorites du Quercy') he employs both *Palæochærus* and *Charomorus*.

4 'N. Jahrb.,' 1841, p. 104. 5 *Op. cit.*, p. 196. 6 'Jahrb. Nassau Ver. Nat.,' vol. VI., p. 116, pl. IV. (1850).

7 "Georgensmund," p. 51.

8 "Beitrag," pt. IV., pl. VI.

9 *Op. cit.*

10 The specimens figured by Kaup have distinct columns. 11 "Zool. et Pal. Franç.," 2nd ed., pl. XXXIII., fig. 5.

12 Gervais (*op. cit.*, p. 182) suggested the possibility of the unity of these two forms.

13 *Vide* Gastaldi, 'Mem. Ac. Real. Torino,' ser. 2, vol. XIX., p. 22, pl. VIII., fig. 38.

14 "Zool. et Pal. Franç.," 2nd ed., p. 187, pl. XXXIII., fig. 6.

15 *Op. cit.*, pp. 196, 214. Peters objects to the name *minutum*, and substitutes *cuvieri*; but it would seem that the latter name is really a synonym of *minimum*.

16 Referred in vol. II. of the present work (p. 149, where it is wrongly authenticated as Cuv.) to *Amphitragulus* or *Dichodon*: it is identified by Dr. Filhol ('Mam. Foss. de Ronzan,' [reprint] p. 240) with *Gelocus communis*, which is the same as *Amphitragulus communis*: the same view having been previously taken by Gastaldi (*op. cit.*, p. 23).

4. *HYOTHERIUM PLATYOPS* (Cope¹). Miocene, N. America.*Palæochærus platyops*, Cope.

Said to be the largest species of the genus, but is yet unfigured: pm. 4 is remarkably elongated; and m. 1 narrows internally.

5. *HYOTHERIUM SÆMMERINGI*, H. von Meyer.² Mid. miocene, Europe.*Chæromorus mammilatus*, Gerv. (*teste* Peters).*Sus antediluvianus*, Kaup (*apud* Blain).(?) *Chærotherium dupuii*,³ Lart. (?) *in parte*.*Sus chærotherium*, Blain., *in parte*.*Chærotherium sansaniense*, Lart. (*teste* Peters).*Sus sœmmeringi*, Blain.

The largest European species; of which the molars are of a complex structure, approaching those of *Sus*.

6. *HYOTHERIUM SUBÆQUANS* (Cope⁴). Miocene, N. America.*Palæochærus subæquans*, Cope.

An unfigured species, said to be about the size of *Dicotyles tajacu*: a distinct cingulum on outer side of upper molars.

*7. *HYOTHERIUM SUILLUM* (Pom.). Low. miocene, Europe.*Palæochærus suillus*, Pom.(?) *Amphichærus typus*, Brav.

This species was formed by Pomel on the evidence of a skull in the British Museum (No. 34,961),⁵ and is said to be one-third smaller than *H. typus*. Dr. Filhol,⁶ however, provisionally refers this specimen to the latter species; but he regards the lower jaw figured by Gervais under the name of *H. typus*, as really belonging to that species, whereas Peters has shown that it is probably distinct,⁷ and smaller than the proper jaw of that species. Both the former specimen and the British Museum specimen may, therefore, possibly belong to the same species, which will then be distinct from *H. typus* and may retain the name *H. suillum*.

8. *HYOTHERIUM TYPUS* (Pom.). Up. eocene to low. miocene, France.*Chæromorus simplex*, Gerv.⁸ (*teste* Peters).*Palæochærus typus*, Pom.⁹

A species of about the same size as *H. meissneri*. The crowns of the upper true molars¹⁰ are nearly square, with very simple columns. The lower jaw figured by Gervais¹¹ under the name of *Chæromorus simplex* has been shown by Peters to probably belong to this species.¹² A mandible from Quercy figured by Filhol¹³ under the latter name may likewise be referred to this species.

¹ 'Bull. U. S. Geol. Surv.,' vol. VI., p. 174.

² "Georgensmünd," *loc. cit.*; Peters, *op. cit.*, p. 196, pls. I., II. The synonymy is mainly taken from the latter memoir. *Palæochærus major*, which Peters refers to this species, is, however, on the authority of Dr. Filhol, referred to *H. waterhousi*.

³ Identified by Gervais both with his *C. mammilatus* and *Sus chærotherium*.

⁴ 'Pro. Amer. Phil. Soc.," vol. XVIII., p. 374, 1879.

⁵ A canine of *Amphitragulus* or *Dremotherium* is inserted in this skull.

⁶ 'Ann. Sci. Géol.,' vol. XI., p. 14.

⁷ Peters proposed to restrict the term *H. typus* to this jaw, which only adds to the confusion. If *H. meissneri* and *H. typus* are identical, the latter name should be at once abolished.

⁸ *Op. cit.*, pl. XXXIII., fig. 5.

⁹ 'Bull. Soc. Géol. France,' 2nd ser., vol. IV., p. 381, pl. IV., fig. 1 (1846):

¹⁰ Gervais, *op. cit.*, pl. XXXIII., fig. 1. Gaudry, "Les Enchainements—Mam. Tert.," fig. 83.

¹¹ *Op. cit.*, pl. XXXIII., fig. 5.

¹² That the lower jaw referred by Gervais to *H. typus* is too small for the upper teeth of that species may be seen by comparing the relative dimensions of those teeth with those of *H. waterhousi* figured by Dr. Filhol, and referred to below.

¹³ "Phosphorites du Quercy" (reprint), p. 391, fig. 292.

9. *HYOTHERIUM WATERHOUSI*¹ (Pom.). Low. miocene, France.*Amphucharus major*, Brav.*Palæochærus major*,² Pom.*Hyotherium majus*, Filh.*Palæochærus waterhousi*, Pom.

A species coming next in size to *H. sæmmeringi*, but with molars of the simple structure of *H. typus*; which it considerably exceeds in size. The inner pair of upper incisors are unusually large.

Affinities.—If the above-mentioned European species be referred to two genera, it appears that *H. sæmmeringi* is the only one which should belong to *Hyotherium*; all the rest belonging to *Palæochærus*. The former species, by the more complex structure of its molars, serves to connect the other species with the less specialized forms of *Sus*.³ From the phosphorites of Quercy Dr. H. Filhol⁴ is about to describe the cranium of an allied form under the new generic name of *Dolichochærus*. In that genus the molars are of very simple structure, the last upper molar having no distinct talon, and the parietal portion of the cranium being extremely unlike that of *Sus*; from which it may be concluded that the genus belongs to a very primitive type. In the tertiaries of North America remains of numerous pig-like animals have been discovered apparently connecting *Hyotherium* with *Dicotyles*; several of these species have been referred to the two new genera *Chænohyus* and *Thinohyus*,⁵ whose relation to the other genera is exhibited in the following table, viz.:—

DICOTYLES. Pm. $\frac{3}{3}$ (pm. 2 in contact with pm. 3).

CHÆNOHYUS. Pm. $\frac{3}{3}$ (pm. 2 isolated).

THINOHYUS. Pm. $\frac{4}{4}$ (pm. 1 isolated).

HYOTHERIUM. Pm. $\frac{4}{4}$ (pm. 1 in contact with pm. 2).

The four genera are considered by Prof. Cope to be closely allied; and the fossil forms connect *Dicotyles* so closely with *Sus*, that in a palæontological classification it seems impossible to refer those two genera to distinct families. From the study of the skull of *H. waterhousi* Dr. Filhol⁶ has been led to the conclusion that it is improbable that *Hyotherium* is the direct ancestor either of *Dicotyles* or *Sus*; but it is most probable from the structure of its molars that it must have been intimately related with such ancestral stock. The later premolars are relatively stouter than in existing species of *Sus*. The canines are small, and in *H. sæmmeringi* the root of the upper one is double: there is no distinct diastema, and (at least in several species) the lower canines had not attained the peculiar form of those of *Sus*.

Distribution.—It is only recently that the genus has been recorded from

¹ Vide Filhol, 'Ann. Sci. Géol.,' vol. XI., pls. IV.-IX.

² Identified with this species on the authority of Dr. Filhol (*op. cit.*, p. 19): it is identified by Peters (*op. cit.*, p. 136) with *H. sæmmeringi*.

³ Gaudry, "Les Enchainements—Mam. Tert.," p. 71.

⁴ The present writer is indebted to Dr. Filhol for early information concerning this undescribed genus, and also for proofs of the illustrations to accompany his forthcoming memoir upon the same.

⁵ Cope, 'Proc. Amer. Phil. Soc.,' vol. XVIII., p. 373, 1879. *Palæochærus condoni*, Marsh, should be referred to *Platygonus* or *Thinohyus*, according to Prof. Cope.

⁶ 'Ann. Sci. Géol.,' vol. XI., p. 81.

America,¹ where it occurs in the miocene. In Europe it ranges from the upper eocene (Querry phosphorites) to the middle miocene (Sansan stage); and is found from France to Styria. Its distribution in India will be mentioned in the sequel.

Species: *HYOTHERIUM SINDIENSE*, *nobis*.

History.—In 1878 the present writer briefly mentioned² some detached molar teeth of a suilline animal obtained by Messrs. W. T. Blanford and F. Fedden from the lower Siwaliks of Sind, which were referred to *Hyotherium*, with the provisional name of *H. sindiense*. It is these and other specimens from the same region which form the subject of the present notice.

Upper cheek-teeth.—In plate XII., fig. 6, there is represented a fragment of the left maxilla containing the second and third true molars of a suilline animal, which from the form and structure of these teeth may probably be referred to the present genus. Both teeth are well-worn, but are unfortunately much decayed, so that the characters of their worn surfaces cannot be determined. In size and contour they agree almost exactly with the corresponding teeth of *H. saemmeringi* figured by Peters.³ In figure 12 of the same plate there is represented an unworn molar of the right side, which from its agreeing in size with m. 2 of the last specimen may be regarded as the homologous tooth of the same species. This tooth agrees very closely with m. 2 of *H. saemmeringi*, with the exception of having no cingulum on the outer surface: the accessory columns (*a*, *g*, *h*) are more strongly developed and have a more complete union with the inner main columns than is the case with *H. waterhousi*,⁴ or *H. typus*; the molars of which are also distinguished by the more square form of the summit of their crowns.⁵ The present tooth is distinguished from m. 2 of a true pig like *Sus hysudricus* (pl. VIII., fig. 10) by its relatively wider crown, and by the columns being lower, and somewhat more distinctly defined: it is, however, almost exactly intermediate between the corresponding tooth of *H. typus* and *S. hysudricus*. In fig. 11 of the same plate there is represented a half worn right upper molar which might well be m. 1 of the same species as the last specimen: a tooth described in the sequel indicates, however, that it might be m. 2 of a smaller form. In this specimen there is a distinct crenulated cingulum on the outer side of the posterior outer main column;—a similar cingulum girding both columns in *H. saemmeringi*. In fig. 10 of the same plate there is represented a still more worn (probably) left molar agreeing in size with the last specimen. In figures 13 and 14 of the same plate there are represented two similar right upper molars of smaller size than any of those described above. These teeth are of too small a size to have been m. 1 of an individual of the size of those to which figs. 6 and 12 belonged; but if the specimen represented in fig. 11 were a second molar they

¹ The correctness of Prof Cope's generic determination is of course assumed

² "Records," vol. XI, p. 77.

³ *Op. cit.*, pl. I., fig. 1

⁴ *Filhol, op. cit.*, pl. VI.

⁵ It is somewhat difficult to give a correct estimate of the relative proportions of the crowns of the molars of many species, owing to the circumstance that the outer walls of the base of the crown are very sloping.

might have been $\overline{m.1}$ of the same form. As these teeth do not appear to present any characters, except that of size, by which they can be distinguished from fig. 12, it is obvious that it is impossible to say whether fig. 11 be $\overline{m.2}$ of the smaller or $\overline{m.1}$ of the larger form. The small teeth are almost indistinguishable from specimens in the Indian Museum from Germany, which, on the authority of Klipstein, are referred to the ill-defined *H. medium*.

In figures 9 and 15 of the same plate there are represented two last upper premolars of a pig-like animal, belonging to opposite sides of the jaw, which may probably be referred to the present genus. The smaller specimen agrees in relative size with fig. 13, and the larger with fig. 6. The two teeth agree very closely in structure, although the smaller one has a more distinctly developed cingulum: they resemble to a great extent the corresponding tooth of *H. saemmeringi*; but are distinguished by the two outer columns being less equal in size, as well as by the greater development of the transverse ridges connecting the inner columns with the two outer columns. In *H. waterhousi*, *H. typus*, and most other species, these connecting ridges are scarcely developed at all.

Lower molars.—In figures 7, 8, of plate XII. there are represented two right lower true molars in a well-worn condition, which agree with those of the present genus. The one represented in fig. 8 may from its size be regarded as $\overline{m.1}$, and agrees in relative size with the small upper teeth represented in figs. 13, 14. The second specimen may be regarded either as $\overline{m.2}$ of the same form, or as $\overline{m.1}$ of the larger form represented in figs. 6 and 12. Both these teeth agree in general proportions, and, as far as can be seen, in structure, with the lower molars of *H. saemmeringi*: the smaller specimen agreeing with $\overline{m.1}$ of a small individual of that species figured by Peters¹; and the larger with $\overline{m.2}$ of the same specimen, and also with $\overline{m.1}$ of a larger individual figured by the same writer.² In figure 16 of the same plate there is represented a fragment of the right ramus of a mandible containing $\overline{mm.4}$ and $\overline{m.1}$; both in an unworn condition. The true molar is of the same size as the specimen represented in fig. 8: it is of smaller size, and the columns are of a more simple structure than in the corresponding tooth of *Sus hysudricus* (pl. VIII., fig. 8).

Distinctness and affinities.—With the materials at present available it is impossible to say whether the larger and smaller teeth noticed above belong to one or two species. Their similarity in structure, coupled with the variation in the size of the teeth referred to *H. saemmeringi* (assuming all of them to be rightly associated), seems, however, to be in favour of the former alternative. It is also impossible to say whether such species belonged to *Hypotherium* or to one of the allied American genera; but in the absence of any evidence to the contrary it may, from the resemblance of the teeth to those of *H. saemmeringi* be, at least provisionally, referred to that genus. The larger specimens indicate a species of the size of the larger

¹ *Op. cit.*, pl. II., fig. 6.

² *Ibid.*, fig. 7.

form of *H. scæmmeringi*, and therefore larger than all other forms except *H. waterhousi*, and the unfigured American *H. platyops*. From *H. waterhousi* (and *H. typus*) the Sind form is distinguished by the structure of its molars, but it cannot be compared with *H. platyops*. That it was closely allied to *H. scæmmeringi* is pretty evident, but the materials at hand are insufficient to determine definitely whether the two are distinct or not. To mark its place of origin the Sind form may retain the provisional name of *H. sindiense*. Should it be eventually found that the larger and smaller teeth belong to more than one species the foregoing name may be restricted to the larger form.

Distribution.—As already mentioned, all the specimens described above were obtained from the lower Siwaliks of Sind.

HYOTHERIUM, sp.

Lower molar.—In plate XII., fig. 5, there is represented a second left lower true molar of a pig-like animal, which probably belongs to the present genus. The tooth is implanted in a fragment of the mandible, showing a part of the alveolus of $\overline{m.3}$, so that there can be no doubt as to its serial position. The specimen was among the collection of the Asiatic Society of Bengal transferred to the Indian Museum, and was obtained from the Siwaliks of Perim Island. The tooth is but very slightly worn, and the columns are comparatively simple and distinct: the crown is relatively wider than the lower molars of *Hyotherium scæmmeringi* and the corresponding teeth from Sind, and it is therefore probable that the present specimen belongs to a large species distinct from either. The lower molars of the large *H. waterhousi*¹ are also of a more elongated type than the specimen under consideration; and as the writer has been unable to identify the latter with any described form it appears highly probable that it indicates a new species; although it is necessary to await further specimens before this can be definitely determined.

EVOLUTION OF THE SUIDÆ AND THEIR ALLIES.

At the close of the foregoing descriptions it may be well to record a few observations deduced therefrom as to the probable line of evolution of the *Suidæ* and their allies. The observations of M. Filhol have shown that in *Hyotherium*, which is one of the oldest forms of the family, the canines and lower incisors had not attained the specialized structure of those of the existing pigs; while the absence of a diastema and the simple structure of the molars are also characters indicating a primitive type. Although, as M. Filhol suggests, it is quite probable that this genus is not on the direct ancestral line of the modern pigs; yet it was evidently closely connected with such primitive stock. The undescribed genus *Dolichoærus* apparently indicates a form still closer to the same primitive stock. The remarkable agreement in cranial characters and the structure of the cutting-teeth existing between *Hyotherium* and *Hippohyus* indicates that the latter should in all

¹ Filhol, *op. cit.*, pl. VII.

probability be regarded as a highly specialized branch of the *Hyotherium* stock. The structure of the molars of *Sanitherium* likewise suggests that this genus may be another offshoot from the same branch. In some forms of *Hyotherium* (*H. typus*) the crowns of the true molars are nearly square, and the premolars are usually stouter than those of existing pigs; and these forms may be regarded as the most primitive.

Turning to the genus *Sus*, it has been shown that the crowns of the molars of several of the earlier forms were relatively short, and that the premolars, especially those of the lower jaw, were larger in proportion to the true molars than is the case among most existing species; the latter character culminating in the mandible provisionally referred to *S. giganteus*. The resemblance of the teeth of that jaw to those of *Tetraconodon* indicates that the group (entelodonts) to which that genus belongs and *Sus* are diverging branches of one stock, which was probably closely connected with the primitive hyotheroid stock. In the entelodont branch the premolars appear to have gone on increasing in relative size, till they attained their greatest development in *Tetraconodon* itself; and it is not improbable that some of the anthracotheroids may have taken origin from an early branch of the same stock. The extreme simplicity of the structure of the molars of *Tetraconodon* indicates that this genus has not descended from *Sus*.

In the true pigs, on the other hand, the premolars having attained in the lower jaw of one form (? *S. giganteus*) a comparatively large development, ever afterwards began to diminish in relative size, and subsequently in number; while progressive development, both as regards size and complexity of structure, was transferred to the true molars, and especially to the last tooth of that series. Thus while in the mandible provisionally referred to *S. giganteus* m. 1 and m. 2 are remarkably short, and the talon of m. 3 is comparatively long, the premolars being of great size; in the form here called *S. titan* the first two molars have increased in relative length, although the last tooth still retains its simple talon; the lower premolars being still relatively larger than in existing pigs. In *S. falconeri* the early molars have become still more elongated and complex, and the last tooth of some individuals has attained a length and a complexity of structure unknown among any existing members of the genus; the lower premolars being much narrower than in any of the previous forms. This branch appears to have culminated in the existing African genus *Phacochoerus*, where the last molar has become extremely narrow and complex, and in its tall crown, and in its persistence after all the earlier teeth have disappeared foreshadows, or parallels, a proboscidian type. In this genus the gradual diminution in the size of the premolars has culminated in the non-development of the first in the upper, and of the first and second in the lower jaw, and in the relatively small size and early disappearance of the remaining teeth.

Of the existing species of true pigs, the African river-hogs exhibit traces of a primitive type in their relatively large premolars, short m. 1 and m. 2 and small

talon of m. 3; although the absence of the first premolar is a more specialized character, albeit one found in some tertiary species (*S. erymanthius*, etc.). The stout premolars and the short m. 3 of some of the tertiary forms like *S. palæochærus* and *S. hysudricus* indicate that it is not improbable that the river-hogs may have descended from some such form. *S. barbatus* in its small m. 3 almost certainly shows signs of a direct descent from a primitive stock; and the writer is inclined to think that the same may be said of *S. vittatus* and the *S. andamanensis* group. The resemblance of the teeth of the latter to those of *S. hysudricus* renders it by no means improbable that the one may be the descendant of the other; and if the writer is at all correct in supposing that *S. vittatus* is descended from *S. giganteus* this would indicate that the *S. vittatus* and the *S. andamanensis* groups are not specifically the same. The first and second molars of *S. vittatus* are relatively longer than in *S. giganteus*, which is a character that might be expected to occur in the newer form. The longer m. 3 of *S. cristatus* indicates that it may well be a more specialized form of the *S. vittatus* stock. The proportions of the molar teeth of *S. verrucosus* are not unlike those of the form here named *S. titan* (assuming that to be distinct from *S. giganteus*), with the exception that m. 3 is generally longer in proportion to the two preceding teeth¹; and the writer would suggest the possibility of the one being the degenerate descendant of the other. In any case it is highly probable that the *S. verrucosus*, *S. vittatus* (including *S. cristatus*), and *S. andamanensis* groups are descendants of some of the three medium or large forms of Siwalik pigs with simple molars; and the undoubted existence of the three fossil forms² renders it, *primâ facie*, probable that the existing Asiatic species (exclusive of *S. barbatus* and *S. salvanius*) are more than two in number. The probability of the descent of *S. salvanius* from *S. punjabiensis* has been already noticed.

Babirussa in its simple molars shows evidence of affinity with some of the primitive forms; and the same may be said still more decidedly with respect to *Dicotyles*. The connection of the latter genus with *Hypotherium* and its allies cannot be determined till the affinities of the extinct America genera noticed above have been fully worked out.

FAMILY III.: ENTELODONTIDÆ.³

GENUS: TETRACONODON, Falc.

Species: TETRACONODON MAGNUS,⁴ Falc.

This genus and species, which are both peculiar to the Siwaliks are only known

1 The dimensions of the upper molars of three specimens of *S. verrucosus* are as follows:—

	m. 1	m. 2	m. 3
1. Borneo	1 24		1 24
2. Java	1 53		1 49
3. Ceram	1 54		1 47

2 Even if *S. titan* should be eventually proved to be only a large variety of *S. giganteus*, the lower jaw provisionally assigned to the latter will indicate another species.

3 Prof. Flower ("Catalogue of Osteological Specimens in Mus. Roy. Coll. Surgeons," pt. II., p. 341, 1894) refers the present group to the family *Chæropotamidae*. He also adopts the generic term *Hypotherium*, Pom. (1847), in place of *Entelodon*, Aym. (1818), the very general adoption of the latter by continental paleontologists induces the present writer to retain it. *Archæotherium*, Leidy, is a later synonym.

4 *Olim, magnum, errorum.*

by some molars and an imperfect mandible; the latter being figured and described in the first volume of this work.¹ The mandible is distinguished from that of *Entelodon* by the absolutely and relatively larger premolars, and the more regularly oblong form of the crowns of the true molars. The genus is considered by Mr. F. Osborn² to be closely allied to the American *Achanodon*³; being, as far as is at present known, distinguished only "by the presence of a few minor tubercles upon the slopes of the molar cusps," and by the larger size of the lower premolars in proportion to that of the true molars. It is quite possible that these distinctions may be only of specific, rather than of generic value.

FAMILY IV.: LISTRIODONTIDÆ.

GENUS: LISTRIODON, H. von Meyer.⁴

Syn. *Lophiochærus*,⁵ Bayle, after Lart., MSS.; *Tapirotherium*, Blainville and Lartet; (?) *Calydonius*, H. von Meyer.

Position of the genus.—There has been much discussion as to the systematic position of this genus, which apparently forms a family of itself; some writers, like De Blainville⁶ and Gervais,⁷ being inclined to refer it to the Perissodactyla; while Lartet (who also at first considered it allied to the tapirs⁸) finally classed it among the bunodont Suina.⁹ The latter view has been adopted by Kowalevsky and other writers; but Prof. Cope¹⁰ in a memoir published 1881 reverted to the original view, and classed *Listriodon* in the *Tapiridæ*. The present writer considering that this view was probably supported by good evidence, adopted it in his own papers; but since no evidence in favour of it has been subsequently published, and as Prof. Cope has given indications of retracting the same,¹¹ it appears advisable to adopt the more general view. That view is confirmed by the presence of a distinct talon to m. 3, and by the form of the upper incisors, as well as by the secant character of the earlier premolars.

In Europe the genus apparently contains only the single species *L. splendens*,¹² H. Meyer, of the middle miocene, which has been found in France, Switzerland, and Styria.

¹ Page 78 (60), pl. X.

² "Contributions from E. M. Mus. Geol. and Archaeol. Princeton Coll. U.S.A.," Bull. No. 3, p. 23, 1883.

³ The same as *Parahyus*, Marsh, according to Mr. Osborn: the present writer was unacquainted with this synonymy when writing "Siwalik Selenodont Suina" in the second volume of the present work.

⁴ 'Neues Jahrb.,' 1846, p. 460.

⁵ The genus *Lophiodon* (at first *Lophiochærus*), Lemoine, is apparently distinct.

⁶ "Ostéographie," Genus *Tapirus*, p. 52, pl. VI. (*Tapirotherium* and *Lophiodon* de Sansan): the writer believes that this part of the *Ostéographie* was published subsequently to 1846, so that *Listriodon* has the priority over *Tapirotherium*; but in any case the former name has met with pretty general acceptance.

⁷ "Zool. et Pal. Franç.," 2nd ed., p. 201: Gervais states that in his own opinion the genus is allied to the tapirs, but in deference to Lartet's opinion he places it among the Artiodactyla.

⁸ "Notice sur la Colline de Sansan," p. 31.

⁹ Vide Gervais, *op. cit.*, p. 201.

¹⁰ 'Pro. Amer. Phil. Soc.,' 1881, pp. 374, 325.

¹¹ In a presentation copy of this memoir sent to the present writer, Prof. Cope has erased *Listriodon* from the *Tapiridæ*.

¹² Syn. *Tapirotherium larteti*, Gerv.; *Listriodon larteti*, Gerv.; *Lophiochærus blainvillei*, Bayle; *Lophiochærus splendens*, (P) Jourd.; *Tapirotherium blainvillei*, Lart.; *Sus tapirotherium*, Blain.; (?) *Calydonius tux*, and *C. tener*, H. von Meyer.

Species 1: LISTRIODON PENTAPOTAMIÆ (Falconer).

Syn. *Tapirus pentapotamiæ*, Falconer. **History*.—The history of the species has been already given in the first volume.¹

Upper molars.—In figures 13 and 17 of plate VIII. the two original specimens on which this species is founded are refigured²: both teeth belong to the right true molar series; and the first (fig. 13), which was obtained by Mr. Theobald from the Siwaliks of the Punjab, is almost unworn, and, from its size, may be regarded as m. 1. The second (fig. 17), which was obtained by Messrs. Garnett and Trotter from the Siwaliks of Kūshalghar, below Attock, is partially worn, and may be regarded as m. 2. In fig. 15 there is represented a much worn and partly broken second left upper molar, which is slightly wider than the specimen represented in fig. 17: this tooth belonged to the same individual as the specimens represented in figs. 14 and 16, and, together with the corresponding tooth of the opposite side, was collected by Mr. Theobald in the Siwaliks of Niki, Punjab: it is in a well-worn condition. The tooth represented in fig. 16 is the third left upper true molar, in a well-worn condition, wanting the postero-internal angle. In fig. 15a there is represented the hinder portion of the third right upper true molar, in an unworn condition, probably belonging to the same individual as the specimen represented in fig. 17. In fig. 14 there is represented the much-worn first right upper incisor belonging to the same individuals as figs. 15, 16. In the following table the dimensions of the above-mentioned teeth are compared with those of a specimen of the right maxilla of *Listriodon splendens* in the Lyons Museum, the measurements being taken from a plaster cast in the British Museum (No. 40,959):—

	L. pentapotamiæ.					L. splendens.
	fig. 13	fig. 17	fig. 15	fig. 16	fig. 15a	
Length of m. 1	0·81					0·73
Width „ „ „ at first ridge	0·75					0·7
„ „ „ „ „ second „	0·74					0·69
Length „ „ „ 2		0·81	0·8			0·8
Width „ „ „ „ „ first „		0·83	0·85			0·78
„ „ „ „ „ second „		0·8	0·75			0·74
Length „ „ „ 3						1·0
„ „ „ hind-ridge and talon of ditto					0·64	0·5
Width „ „ „ ditto at first ridge				0·88		0·83
„ „ „ „ „ second „					0·81	0·73

The dimensions of the Indian teeth are such that all the specimens may, at least provisionally, be referred to the same species; and their resemblance to the European form is so close that there can be no doubt of their belonging to the genus *Listriodon*. In size the Indian teeth are rather larger than those of *L. splendens*, but the difference in this respect is so slight that it cannot be regarded as of any specific value. In the upper molar of *L. splendens* figured by Gervais³ the cingulum is more distinctly developed on the outer surface than in the Indian teeth; and the same

¹ Page 70 (52).² The original figures are in vol. I., pl. VIII., figs. 8, 9.³ "Zool. et Pal. Franç.," 2nd ed., pl. XX., fig. 4 (*L. larteti*).

character, judging from the cast, seems to obtain in the Lyons specimen. The most distinctive character of the Indian teeth is, however, the relatively larger talon of *m. 3* (fig. 15a), which forms a wide flat ledge, almost entirely wanting in the Lyons specimen. No other distinctions can be detected between the Indian and European molars.

Incisor.—The first upper incisor (fig. 14) is very similar to an homologous tooth of *I. splendens* in the British Museum, and also closely resembles the same tooth in *Hyothenium*: it is much longer antero-posteriorly than *i. 1* of *Sus*. On the inner side of this tooth there is a small ledge or cingulum.

Distinctness and affinities.—The foregoing comparisons indicate that the Indian and European forms of *Listriodon* are very closely allied: without additional remains of the former it is, however, impossible to say whether the distinctive points noticed above are of specific value or not; although it is probable that they are. For the present at least the Indian species may retain the specific name of *L. pentapotamiae*.

Distribution.—The specimens described above are all the known remains of the species, and, as already mentioned, were all obtained from the Siwaliks of the Punjab.

Species 2: *LISTRIODON THEOBALDI*, *nobis*.

History.—The only previous notice of this provisional species is a preliminary one in the "Records" for 1878,¹ referring to the one molar on which it is founded.

Upper molar.—The above-mentioned tooth, which is the only specimen known, was obtained by Mr. Theobald from the Siwaliks of the village of Jabi, in the Punjab, and is represented in plate VIII., fig. 12. From the width of its crown this molar seems to belong to the upper jaw, and is of the right side: it is in an early condition of wear, and, if belonging to the permanent series, is either *m. 1* or *m. 2*. The tooth differs from the molars of *L. pentapotamiae* by its greatly inferior size, and by the transverse valley being wider and more open, as well as by the absence of the oblique ridges running from the fore-and-aft cingula to the summits of the two main ridges.

Assuming this tooth to belong to the permanent series, its greatly inferior size would leave no reasonable doubt of its being specifically distinct from *L. pentapotamiae* and *I. splendens*. There is, however, no certain reason why this tooth should not be the last upper milk-molar (which in the pigs has the same form as the permanent molars), in which case it might at first sight be regarded as belonging to *L. pentapotamiae*. In the pigs, however, no difference in structure can be detected between *mm. 4* and *m. 1*, and the difference in the size of those teeth is considerably less than that between the specimen under consideration and the first molar of *L. pentapotamiae* represented in plate VIII., fig. 13. On these grounds it is unlikely that the present specimen is *mm. 4* of that species; and it is accordingly probable that it indicates a second Siwalik species of *Listriodon*, which may retain the provisional name of *L. theobaldi*.

LIST OF MEMOIRS.

- ADAMS, A. L. "Notes on the Nile Valley and Malta." Edinburgh, 1870 (*Hippopotamus*, p. 212).
- BAKER, W. E. "Selected specimens of the Sub-Himalayan Fossils in the Dádúpúr collection." '*Journ. Asiat. Soc. Beng.*,' vol. IV., p. 565 (1835). (*Sus*)
- , and DURAND, H. M., "Sub-Himalayan Fossil Remains of the Dádúpúr collection." '*Journ. Asiat. Soc. Beng.*,' vol. V., p. 661 (1836). (*Sus*)
- BAYLE, —. "Notice sur le *Listriodon splendens*, etc." '*Bull. Soc. Géol. France*,' ser. 2, vol. XIII., pp. 24-30 (1856).
- CHAPMAN, H. C. "Observations on the Hippopotamus." '*Proc. Ac. Nat. Sci. Philad.*,' 1881, p. 126.
- COPE, E. D. "On the Nimravidæ and Canidæ of the Miocene Period." '*Bull. U. S. Geol. Surv.*,' vol. VI., p. 174 (*Hyotherium* [*Palæochærus*] *platyps*). (1882).
- "The Systematic Arrangement of the Order Perissodactyla." '*Proc. Amer. Phil. Soc.*,' vol. XIX., p. 377 (*Listriodon*). (1881).
- "Second Contribution to a knowledge of the Miocene Fauna of Oregon." '*Proc. Amer. Phil. Soc.*,' vol. XVIII., p. 370 (Suillines). (1880).
- FALCONER, H. "Note on the existing *Hippopotamus liberiensis*, Morton, with Synopsis of the *Hippopotamidæ*, fossil and recent." "Palæontological Memoirs," vol. II., p. 404.
- and CAUTLEY, P. T. "On the fossil *Hippopotamus* of the Sewalik Hills." '*Asiatic Researches*,' vol. XIX., p. 39. (1836).
- FILHOL, H. "Etude des Mammifères Fossiles de St. Gérard-le-Puy (Allier)." '*Ann. Sci. Géol.*,' vols. X., XI. (1879-80). (*Hyotherium*).
- "Note relative a un nouvelle espèce de *Sus* fossile trouvée dans les argiles à *Dinotherium*, etc." '*Bull. Soc. Philom. Paris*,' vol. VI., p. 123 (1882). (*Sus valentini*.)
- FORSYTH-MAJOR, C. J. "Studien zur Geschichte der Wildschweine (Gen. *Sus*)." '*Carus' Zoologischer Anzeiger*,' vol. VI., p. 259 (1883).
- "Studii sugli avanzi pliocenici del genere *Sus* (*S. strozzi*, Menegh.)." '*Proc. Verb. Soc. Tosc. Sci. Nat.*,' vol. II., p. 227 (1881).
- FRAAS, O. "Die Fauna von Steinheim." Stuttgart, 1870. (*Sus* [*Chacropotamus*] *steinheimensis*.)
- GARSON, J. G. "Notes on the Anatomy of *Sus salvanius* (*Porcula salvania*, Hodgson)." '*Proc. Zool. Soc.*,' 1883, p. 413.
- GASTALDI, B. "Cenni sui Vertebrati Fossili del Piemonte." '*Mém. Real. Ac. Torino*, ser. 2, vol. XIX., p. 19 (*Hyotherium* [*Anthracotherium*] *minimum*). (1861.)
- GAUDRY, A. "Animaux Fossiles et Géologie de l'Attique." Paris, 1862-7 (*Sus erymanthius*).
- "Animaux Fossiles du Mont Léberon." Paris, 1873 (*Sus major*).
- "Sur un Hippopotame fossile découvert à Bone (Algérie)." '*Bull. Soc. Géol. France*,' ser. 3, vol. 4, p. 501, pl. XVII. (1876). (*Hippopotamus hipponensis*.)
- GERVAIS, P. "Zoologie et Paléontologie Françaises," 2nd ed. Paris, 1859.
- KAUP, J. J. "Beiträge zur näheren Kenntniss der Urweltlichen Säugethiere," part 4. Darmstadt, 1859.
- "Ossements Fossiles de Darmstadt," part 2. Darmstadt, 1833.
- KITTLE, E. "Ueber einen neuen Fund von *Listriodon*." '*Verh. k. k. géol. Reichs.*,' 1881, p. 103.
- LARTET, E. "Notice sur la Colline de Sansan." Paris, 1851.

104—70 INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

- M'CLELAND, J. "On the genus *Hexaprotodon* of Falconer and Cautley." '*Journ. Asiat. Soc. Beng.*' vol. VII., p. 1038 (1838).
- MEYER, II. VON. "Die fossilen Zähne und Knochen von Georgensmünd." Frankfort, 1831. (*Hyotherium saemmeringi*.)
- Note on Fossil Vertebrates. '*Neues Jahrb.*' 1841, pp. 101-104 (*Hyotherium*, p. 104 : 1846, pp. 462-476 (*Listriodon*, p. 466).
- OSBORN, H. F. "On *Achanodon*, an Eocene Bunodont." '*Contrib. E. M. Mus. Geol. Archæol. Princeton Coll.*' Bull. No. 3, p. 23 (1883).
- "Schädel von *Hyotherium meissneri* aus dem Tertiärkalke des Salzbachthales bei Wiesbaden." '*Jahrb. Nassau Ver. Nat.*' vol. VI., p. 116, pl. IV. (1850).
- OWEN, R. "Description of some Mammalian Fossils from the Red Crag of Suffolk." '*Quart. Journ. Geol. Soc.*' vol. XII., p. 217 (1856.) (*Sus antiquus* and *S. palæochærus*.)
- PETERS, K. T. "Zur Kenntniss der Wirbelthiere aus dem Miocänschichten von Eibiswald in Steiermark." '*Denkschr. k. Ak. Wiss.*'—*math. nat. class*, vol. XXIX, p. 189, pls. I., II. (1869). (*Hyotherium saemmeringi*.)
- POMEL, A. "Note sur des Animaux Fossiles de l'Allier." '*Bull. Soc. Géol. France*,' ser. 2, vol. IV., p. 378 (1846). (*Hyotherium* [*Palæochærus*] *typus* and *H. major*.)
- "Observations paléontologiques sur les Hippopotames et les Cochons." '*Bibl. univ. Genève, Arch.*' vol. VIII., p. 159 (1848). (*Sus lockharti*, *S. chæroides*.)
- ROLLESTON, G. "On the Domestic Pig of Prehistoric Times in Britain, and on the mutual Relations of this variety of Pig and *Sus scrofa ferus*, *Sus cristatus*, *Sus andamanensis*, and *Sus barbatus*." '*Trans. Linn. Soc.*' Zool., ser. 2, vol. I., p. 251 (1877).
- RÜTIMEYER, L. "Einige weitere Beiträge über des zahme Schwein und das Hausrind." '*Verh. nat. Ges. Basel*,' vol. VI., pt. 3, p. 463 (1877).
- "Neue Beiträge zur Kenntniss des Torfschweins." '*Verh. nat. Ges. Basel*,' vol. IV., pt. 1, p. 139 (1864).
- "Ueber lebende und fossile Schweine." '*Verh. nat. Ges. Basel*,' vol. I., p. 517 (1857).
- VACEK, M. "Ueber einen Unterkiefer von *Hyotherium meissneri*." '*Jahresb. Mus. Ver. Vorarlberg*,' 1881.

PLATE VI.

ARTIODACTYLA — *Hippopotamidae*.

Fig 1. HIPPOPOTAMUS SIVALENSIS, Falconer and Cautley — Greater part of the left ramus of the mandible of a small variety, with the teeth in a middle condition of wear, from the Siwaliks of the Punjab: Indian Museum (No. B 395)

„ 2. HIPPOPOTAMUS PALINDICUS, Falconer and Cautley — Symphyseal extremity of the mandible, with the crowns of the teeth broken off, from the Narbadas. Indian Museum (No. F. 119)

Both figures, nat. size



1



PLATE VII.

ARTIODACTYLA — *Suidæ*.

- Fig. 1. *SUS FALCONERI*, Lyd. Dentition of the right ramus of the mandible of a female, from the Siwalik Hills; Dublin Museum of Science and Art (No. C. 27): the cheek-teeth are well worn.
- „ 2. *SUS FALCONERI*, Lyd. Fragment of the right ramus of a mandible from the Siwaliks of Náhan, containing the two last molars: $\overline{m. 2}$ is well worn, but $\overline{m. 3}$ is almost untouched: Indian Museum (No. B. 16).
- „ 3. *SUS HITAN*, Lyd. Last right lower true molar, in an early condition of wear, with the anterior columns split; from the Siwaliks of the Potwár district of the Punjab: Indian Museum (No. B. 15).
- „ 4. *SUS HITAN*, Lyd. Dentition of the greater portion of the right ramus of the mandible, from the Siwaliks of the Potwár district, containing the four last cheek-teeth, the last untouched by wear: Indian Museum (No. B. 4).
- „ 5. *SUS FALCONERI*, Lyd. The upper true molars of the right side (reversed from those of the left), from a palate specimen from the Siwalik Hills: the last tooth untouched by wear: British Museum.
- „ 6. *SUS HITAN*, Lyd. Last right upper true molar, in an almost unworn condition, from the Siwaliks of Asnot, Punjab: Indian Museum (No. B. 19).
- „ 7. *SUS FALCONERI*, Lyd. The right upper cheek-dentition of the cranium of a female represented in plate X.: all the teeth in a well-worn condition.
- „ 8. *SUS FALCONERI*, Lyd. Second and third right upper true molars, the last in an early stage of wear, from the Siwalik Hills: Indian Museum (No. B. 18).
- „ 9. *SUS FALCONERI*, Lyd. Inner lateral aspect of the last molar of the specimen represented in fig. 2.
- „ 10. *SUS HITAN*, Lyd. Inner lateral aspect of the last molar of the specimen represented in fig. 4.

All the figures natural size. Owing to an inadvertence the letters *g. h* in figure 6 correspond to *f, g* in figs. 5, 8.

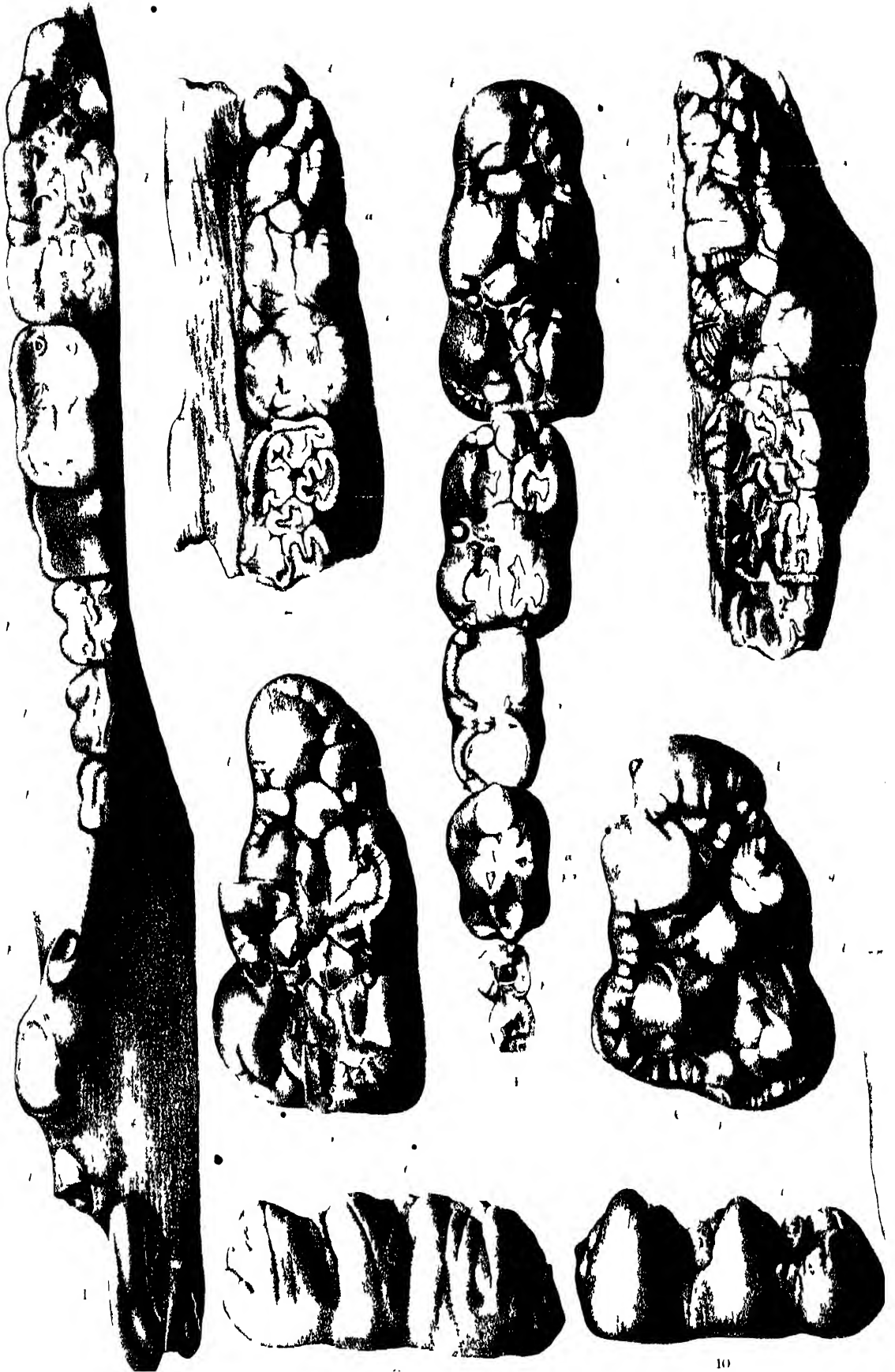


PLATE VIII.

ARTIODACTYLA — *Suidæ* and *Listriodontulæ*.

- Fig. 1. *SUS TILAS*, Lvd. Fragment of the right ramus of the mandible of a male, with the teeth in a middle stage of wear; from the Siwaliks of Asnot, Punjab: Indian Museum (No. B. 435).
- „ 2. *SUS HYSTRICUS*, Falc. and Caut. Hinder portion of the right ramus of the mandible, with the teeth in a well-worn condition; from the Siwaliks of Lehri, Punjab: Indian Museum No. B. 31.
- „ 3. *SUS HYSTRICUS*, Falc. and Caut. The greater part of the right ramus of the mandible, with the teeth in a well-worn condition; from the Siwaliks of the Potwâr district, Punjab: Indian Museum (No. B. 30). 3a, inner view of m 3 of same.
- „ 4. *SUS*, sp. Symphyseal extremity of the left ramus of the mandible, with the teeth very slightly worn; from the Siwaliks of Asnot, Punjab: Indian Museum (No. B. 10). 4a from the outer aspect.
- „ 5. *SUS HYSTRICUS*, Falc. and Caut. Fragment of the right ramus of the mandible of a young individual, with the teeth in a middle stage of wear; from the Siwaliks of Asnot, Punjab: Indian Museum (No. B. 50).
- „ 6. *SUS HYSTRICUS*, Falc. and Caut. Fragment of the left ramus of the mandible of a young individual, with the teeth more worn than in the last specimen; from the Siwaliks of Kûshalghar, Punjab: Indian Museum (No. B. 436).
- „ 7. *SANIIHERIUM SCHLAGENFWILTI*, Meyer. Fragment of the right ramus of the mandible, containing a part of m 3 in an early stage of wear; from the Siwaliks of Kûshalghar: Indian Museum No. B. 87).
- „ 8. *SUS HYSTRICUS*, Falc. and Caut. Fragment of the right ramus of the mandible of a very young individual, with the teeth in an unworn condition; from the Siwaliks of Jabi, Punjab: Indian Museum (No. B. 53).
- „ 9. *SUS PUNJABIENSIS*, Lvd. Hinder portion of the left ramus of the mandible, with the teeth in a middle condition of wear; from the Siwaliks of Asnot: Indian Museum (No. B. 61). 9a, inner view of m 3 of same.
- „ 10. *SUS HYSTRICUS*, Falc. and Caut. Fragment of the right maxilla, containing the true molars in an early stage of wear, from the Siwaliks of Asnot: Indian Museum (No. B. 45).
- „ 11. *SUS HYSTRICUS*, Falc. and Caut. Part of the left maxilla, with the teeth more worn than in the last specimen; from the Siwaliks of Asnot: Indian Museum (No. B. 46).
- „ 12. *LISTRIDON THEOBALDI*, Lvd. First or second right upper true molar (?), in an early stage of wear, from the Siwaliks of the Punjab: Indian Museum (No. B. 109).
- „ 13. *LISTRIDON PENTAPOTAMI* (Falc.). The first right upper true molar, in an unworn condition; from the Siwaliks of the Punjab: Indian Museum (No. B. 107, a).
- „ 14. *LISTRIDON PENTAPOTAMI* (Falc.). The first right upper incisor, in a well-worn condition; from the Siwaliks of Niki, Punjab: Indian Museum (No. B. 108, a).
- „ 15. *LISTRIDON PENTAPOTAMI* (Falc.). The second left upper true molar, in a well-worn condition; from the Siwaliks of Niki: Indian Museum (No. B. 108).
- 15a. *LISTRIDON PENTAPOTAMI* (Falc.). The hinder part of the third right upper true molar, from the Siwaliks of Kûshalghar: Indian Museum (No. B. 107).
16. *LISTRIDON PENTAPOTAMI* (Falc.). The third left upper true molar, in a well-worn condition; from the Siwaliks of Niki: Indian Museum (No. B. 108).
17. *LISTRIDON PENTAPOTAMI* (Falc.). The second right upper true molar, in a slightly worn condition; from the Siwaliks of Kûshalghar: Indian Museum (No. B. 107).

All the figures natural size: the molars of Listriodon are viewed from the inner aspect; all the others from the anterior aspect.



PLATE IX.

ARTIODACTYLA — *Suidæ*.

SUS THIAN, Iyd Cranium and mandible of a male, from the Siwaliks of Niki, Punjab Indian Museum
(No. B 26) $\frac{1}{2}$ nat. size From the left lateral aspect



PLATE X.

ARTIODACTYLA — *Suidæ*.

Figs. 1, 2. *SUS FAISONERI*, Lyd. Cranium of a female, from the Siwalik Hills: Science and Art Museum, Dublin (No. C. 27) $\frac{1}{2}$ nat. size. Fig. 1 from the frontal; fig. 2 from the right lateral aspect.



PLATE XI.

ARTIODACTYLA — Suidæ.

Fig. 1. (r) *SUS GIGANTEUS*, Falc. and Caut. Mandible, with the teeth in a well-worn condition; from the Siwaliks of Asnot, Punjab: Indian Museum (No. B. 1).

2. *SUS GIGANTEUS*, Falc. and Caut. Right upper cheek-dentition, in a well-worn condition; from a cranium from the Siwalik Hills: British Museum (No. 16,166).

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Both figures natural size.



PLATE XII.

ARTIODACTYLA — *Suidæ*.

- Fig 1 *SUS TILIAN*, Lyl Distal half of the left radius, associated with the cranium figured in plate IX Indian Museum (No. B. 13) . from the anterior aspect.
- „ 2 *SUS TILIAN*, Lyl The third and fourth left metacarpals, associated with the last specimen : Indian Museum (No. B. 13a).
- „ 3. *HIPPOHYUS SIVALENSIS*, Falc and Caut Part of the right ramus of the mandible, with the teeth much worn ; from the Siwaliks of Kolsa, Punjab Indian Museum (No. B. 64).
- „ 4 *HIPPOHYUS*, sp Hinder part of the left ramus of the mandible, with the teeth in a medium condition of wear ; from the Siwaliks of Asnot, Punjab Indian Museum (No B. 65).
- „ 5 *HYOTHÆRIUM*, sp A second left lower true molar, in a slightly worn condition ; said to be from the Siwaliks of Perim Island Indian Museum (No B. 101)
- „ 6 *HYOTHERIUM SINDIENSE*, Lyl Fragment of the left maxilla containing the second and third true molars, in a much worn and eroded condition , from the lower Siwaliks of Sind . Indian Museum (No B 102).
- „ 7. *HYOTHERIUM*, sp The first or second right lower true molar, in a well-worn condition ; from the lower Siwaliks of Sind Indian Museum (No. B 99)
- „ 8. *HYOTHERIUM*, sp A first right lower true molar, in a well-worn condition ; from the lower Siwaliks of Sind Indian Museum (No B 99a).
- „ 9 (?) *HYOTHÆRIUM*, sp A fourth left upper premolar, in an unworn condition ; from the lower Siwaliks of the Laki Hills, Sind . Indian Museum (No B 98).
- „ 10. *HYOTHERIUM*, sp A first or second upper true molar, in a very much worn condition , from the lower Siwaliks of the Laki Hills Indian Museum (No B. 96).
- „ 11. *HYOTHERIUM*, sp A first or second right upper true molar, in a well-worn condition , from the lower Siwaliks of the Laki Hills Indian Museum (No. B 96a).
- „ 12 *HYOTHERIUM SINDIENSE*, Lyl A second right upper true molar, in an unworn condition ; from the lower Siwaliks of the Laki Hills, Indian Museum (No B. 96b)
- „ 13 *HYOTHERIUM*, sp A first right upper true molar, in an unworn condition , from the lower Siwaliks of the Laki Hills Indian Museum (No B 97a).
- „ 14. *HYOTHERIUM*, sp A first right upper true molar, in a slightly worn condition , from the lower Siwaliks of the Laki Hills . Indian Museum (No. B 97)
- „ 15 (?) *HYOTHÆRIUM SINDIENSE*, Lyl A fourth left (?) upper premolar, in a slightly worn condition , from the lower Siwaliks of the Laki Hills Indian Museum (No B 98)
- „ 16 *HYOTHERIUM*, sp A fragment of the right ramus of the mandible, showing mm 4 and m 1 in an unworn condition , from the lower Siwaliks of the Laki Hills . Indian Museum (No B 100)
- „ 17 *HIPPOHYUS SIVALENSIS*, Falc and Caut Fragment of the right maxilla with the teeth in a partially worn condition , from the Siwaliks of Asnot Indian Museum (No B. 65).
- „ 18 *HIPPOHYUS SIVALENSIS*, Falc and Caut. Fragment of the left ramus of the mandible, with m 3 in an unworn condition , from the Siwaliks of Asnot . Indian Museum (No. B 69).
- „ 19 *HIPPOHYUS SIVALENSIS*, Falc and Caut The left half of the symphysis belonging to the same specimen as fig 3
- „ 20 *HIPPOHYUS*, sp Fragment of the left ramus of the mandible, with m 3 in an early stage of wear, from the Siwaliks of Asnot . Indian Museum (No B 69a)
- „ 21 *HIPPOHYUS SIVALENSIS*, Falc and Caut The second and third true molars of the right side, in a well-worn condition, from a palate specimen ; from the Siwaliks of the Punjab . Indian Museum (No B. 66).



